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DECEMBER 11.
British Foundrymen's Association (Sheffield Branch).—"Metals, Crystalline and Amorphous," by Dr. W. Rosenhain.

DECEMBER 12.
British Foundrymen's Association (Scottish Branch).—Discussion on Foundry Problems.
British Foundrymen's Association (Halifax Branch).—"The Foundry Chemist," by A. Harrison (Castleton).

DECEMBER 18.
British Foundrymen's Association (London Branch).—"The Chemist and the Brass Foundry," by R. T. Rolfe, F.I.C. (Bedford).

NOTES AND COMMENTS.

Machinery Depreciation and Income Tax.

The importance of taking correct account of depreciation of plant and machinery appears to be but indifferently appreciated in many industrial concerns; but, nevertheless, in engineering and similar works it is a very important matter if the annual accounts are to represent the actual results of the year's workings. Further, the law of Income Tax as it affects depreciation is by no means clearly understood by many. It may, therefore, not be out of place to briefly review this subject at the present moment. The difficulty of understanding the matter is increased by the fact that the law of Income Tax is spread over many years, with the result that some overlapping occurs. Surveyors of Taxes, too, do not usually appear willing to throw much light on the questions that continually rise. It may be stated that although the principle that capital should not be taxed does not strictly coincide with the law, the actual Income Tax practice, when properly understood, does not introduce many of the possible inequities.

Income Tax procedure is in the hands of an honorary body styled the Commissioners for General Purposes, and known as the District Commissioners, who appoint, and have the legal control of, collectors of taxes. The true functions of such Commissioners are to secure a just assessment, and almost despotic powers are vested in them by law or admitted by practice. They have full authority to protect the taxpayers' interests against inflated and inequitable demands of Surveyors of Taxes, and can generally waive absurd technical points in favour of equity: but concessions *must be asked for*, and the lack of knowledge of the Commissioners' powers is often the cause of taxpayers suffering inequities. In the event of any reasonable point being disputed by the Surveyor of Taxes, the matter should be placed before the Commissioners through their clerk, for in many districts the Commissioners will not take the initiative of adjusting grievances. What are known as Additional Commissioners are part of a body of District Commissioners whose duty is to make the initial assessments, but as they make the assessments they are not allowed to hear and determine appeals. The taxpayer has the option of having on demand, all proceedings in respect of his assessment taken before the Special Commissioners, a body of Government officials, several having been previously connected with the Revenue Department as Surveyors of Taxes; but the taxpayer should bear in mind the disadvantage of assessments by Special Commissioners that assessment and appeal are in the hands of a paid Government Department which is not so open to waive hard technical points in favour of equitable administration as is the local body.

In the event of appeal, the Surveyors of Taxes, as representing the Crown, take a position analogous to that of prosecuting counsel in the courts. The Commissioners, whether District or Special, are practically omnipotent, except that the latter body is

under the control of the Board of Inland Revenue, while District Commissioners are quite independent of the Board. The wide extent of the Commissioners' discretionary powers is not generally sufficiently appreciated.

Claiming for Depreciation.

In the early days of the present income tax, depreciation of plant and machinery was disallowed, on the ground that it represented capital exhausted, and therefore capital withdrawn. This has been modified, however, in the Customs and Inland Revenue Act, 1878, and the Commissioners may now allow such deductions as they think reasonable and just for diminished value by reason of wear and tear. The Finance Act of 1907, Section 26, Subsections 1, 2, 3, and 4, also makes provision with respect to deductions for wear and tear, and gives authority so that if a full allowance cannot, by reason of smallness of profits, be made in one year, the balance may be deducted when the assessment for the following year is being made, and so on for succeeding years. As is well-known, the taxpayer receives early in each year a form on which to return the amount of assessable profits and to claim deductions for depreciation of machinery and plant. The Finance Act of 1907 requires claims for wear and tear to be made on the annual return. This should be complied with, for a Surveyor has been known to argue that the omission to claim the deduction on the return precluded its allowance, even though it were inserted in the accounts ultimately furnished. Any request to be assessed by the Special Commissioners must be made on the return, and if no choice is signified thereon the assessment is dealt with by the District Commissioners. The financial year is from April 6 to the following April 5, and the tax is assessed under schedules ranging from A to E, and each covers a particular class of income. Schedule A deals with buildings and land and Schedule D profits of trade, and each schedule has its own particular rules and regulations.

As to the question of deductible expenses, it must be admitted that there is a tendency on the part of Surveyors to treat legitimate trade expenses as not allowable unless the business itself cannot be *carried on* without such payments, expenses often being ruled out which would be considered necessary and advisable from a sound business standpoint. This attitude is based on the Rule in Schedule D, which states that no sum shall be deducted from profits for any disbursements or expenses whatever, not being money *wholly and exclusively* laid out or expended for the purposes of such trade. The words "wholly and exclusively" are thus read as excluding certain ordinary trade expense of a revenue nature which is made with a view to benefiting the business. That, however, is a matter involving the whole question of deductions, with which we do not propose to deal at the moment.

Coming now to the chief point under immediate consideration, depreciation of machinery and plant is allowed by Section 12 of the Customs and Inland Revenue Act, 1878, which enacts as follows:—"The Commissioners for general or special purposes shall, in assessing the profits or gains of any trade . . . allow such deduction as *they may think just and reasonable*, as representing the diminished value by reason of wear and tear during the year of any machinery or plant used for the purposes of the concern and belonging to the person or company by whom the concern is carried on. . . ." The amount of depreciation is left solely to the discretion of the Commissioners, and their decision cannot be reviewed in any court of law. The usual allowance is 5 per cent. of the written down value, but in the case of machinery of a rapidly wasting character a higher rate may be obtained if the matter is properly placed before the Commissioners, who are in many instances business men of considerable standing.

The depreciation is that for the year of assessment, and the deduction is based on the value of the machinery and plant, as shown in the balance sheet made on April 5, or on such day preceding this date as the accounts are usually made up. No depreciation is allowed on buildings, leases, goodwill, and patents, so that depreciation for income-tax purposes differs from depreciation as understood generally in business. If repairs and renewals of machinery and plant are allowed as a deduction, no depreciation can be admitted. It was decided in one case that a company cannot get deduction for deterioration twice over, first by deducting the actual expense of repair and renewal, and then by deducting an additional estimate for the same thing. Further, loose tools would not be included in the depreciation allowance, the renewals being debited in the accounts.

According to the Finance Act, 1907, no deduction for wear and tear or repayment on account of any such deduction shall be allowed in any year if deduction when added to the deductions allowed on that account in any previous years to the person by whom the concern is carried on will make the aggregate amount of the deductions exceed the actual cost to that person of the machinery or plant, including in that actual cost any expenditure in the nature of capital expenditure on the machinery or plant by way of renewal, improvement, or reinstatement.

Deduction for Obsolescence.

Another fact not properly appreciated is that while an allowance for obsolete machinery is not mentioned in the Income Tax Acts (nor by Surveyors of Taxes), in practice it may be obtained if persistenly pressed for. If machinery has to be scrapped before it is actually worn out, owing to the introduction of more up-to-date plant, a deduction may be made of the value of the out-of-date machinery. Allowance for obsolescence was accepted by the Departmental Committee on Income Tax, which reported in June, 1905, while it has also been stated by a Chancellor of the Exchequer, in reply to a memorial of the Association of Chambers of Commerce, that where a claim is made in respect of the introduction of more modern machinery into a factory, no objection on the part of the Inland Revenue was to be taken to the allowance, as a deduction from the assessable profits of the year, of so much of the cost of replacement as was represented by the existing value of the machinery replaced. These facts should be recalled to the Commisioners and to the Surveyor of Taxes in any case where the question arises. Although such an allowance may not appear to be in accordance with the law, it is obviously equitably correct, and the justice of the deduction would be apparent to the Commissioners if the case were efficiently argued; the matter is solely at the disposal of the Commissioners.

We think it probable that a better knowledge of the foregoing facts would enable many companies to obtain more equitable treatment in the matter of depreciation and Income Tax deduction than they at present obtain at the hands of the Surveyor of Taxes. The latter, it must be remembered, is the representative of the Crown, pressing the Crown's interests; though too often he is regarded by the taxpayer as being the final arbiter in the matter of assessment and deductions.

The Use of Liquid Ferro-Manganese in the Steel Processes.*

By Axel Sahlin (Brussels).

The value of manganese as a deoxidising and solidifying agent in the manufacture of steel was discovered in the early years of the last century. The problem of the most economical and perfect method of adding the percentage of manganese required to the charge of steel has ever since confronted the steelmakers.

In the early days of the Bessemer process, when steel was first produced in large quantities, spiegel iron, containing from 6 per cent. to 20 per cent. of manganese, was universally employed. It was melted in cupolas and run liquid into the converter. The red clouds of smoke continually issuing from the tops of the spiegel cupolas gave unmistakable evidence of the extravagance of this method. When, later, ferro-manganese, the richer alloy of manganese and iron (which is hereafter for the sake of brevity referred to as "ferro") containing from 60 per cent. to 80 per cent. manganese was produced, and thereby the quantity of alloy required for each charge correspondingly brought down, the cupola was found impracticable, and various coke-, coal-, gas-, and oil-fired furnaces were employed without satisfactory results. In works producing high-grade steel, for which cost of manufacture is a secondary consideration, ferro is often melted in crucibles and added liquid. This method, however, is too expensive for general adoption, and the standard procedure of dealing with ferro additions has been to break up the cakes of ferro into lumps of less than fist size, to place the weighed-up quantity of alloy required for the charge on the apron inside the melting furnace doors, and then at the proper moment to push the more or less heated lumps into the bath. In some cases part only of the ferro is placed in the bath, part in the ladle; in yet others the whole quantity is thrown into the ladle. In many works a small furnace is employed for the pre-heating of ferro to dark red. Practice has taught, however, that this method results in a loss of manganese of from 35 per cent. to 18 per cent. (for practical calculations say 20 per cent.) of the metal added, and that for ordinary qualities of steel it is necessary to calculate additions of about 0.8 per cent. of 80 per cent. ferro. If the 20 per cent. of manganese lost could be recovered this would, for a steel plant producing 300,000 tons of steel yearly, and now employing $0.008 \times 300{,}000 = 2{,}400$ tons of ferro, represent a saving of $300{,}000 \times 0.008 \times 0.20 = 480$ tons of ferro, which, at £11 per ton, is equivalent to £5.280 saved yearly.

Whether it pays to make an effort to recover part of this amount depends, of course, on the cost of melting $2{,}400 - 480 = 1{,}920$ tons of ferro.

Until the advent of the electric furnace no suitable appliance for dealing with this problem had been available. Now, however, electric ferro-furnaces are installed in a number of steel plants.

The reasons for the high power consumption in melting ferro may be traced to the following causes:—(1) Intermittence of deliveries. A quantity of molten metal must always be kept on hand ready to tap. This means a continued consumption of heat without equivalent output. (2) Radiation. Both arc and induction furnaces present large and unprotected surfaces of brickwork exposed to atmospheric cooling. In part this is necessary to prevent the flat silica roofs from melting down. (3) Immersion of the lumps of metal in the bath, where they sink to the bottom of the furnace. In the arc furnaces they remain surrounded by the coolest stratum of the liquid metal, which does not circulate and is heated only by the superimposed layers of hotter metal. The solid lumps of ferro also rest on the yet cooler furnace bottom. This causes retarded melting, unnecessary superheating of the surface of the bath, and loss of energy and efficiency. (4) In the arc furnaces the proximity of the electrodes to the bath tends to set up a chemical reaction, and results in a certain loss of metal. This is offset in the induction furnaces by the uneconomical transmission of energy and the difficulty of charging cold metal which must be allowed for.

All the above and other minor and individual defects result in a loss of power, and explain the uneconomical working of the various furnaces on ferro, but they also show that the problem of melting ferro advantageously has not hitherto been solved.

In 1913 there was placed on the market a new type of electric arc furnace, the invention of Mr Ivar Rennerfelt. For our purpose we need only consider the smaller sizes of this furnace as having a practical value for the fusion of ferro, that is the sizes between 6 cwts.—now installed (one of several) at the Hallstahammar Works, Sweden—and one of 2½ tons installed at the works of Ludwig Nobel A.G., St. Petersburg and (one of several) at the Ljusne Works in Sweden. The Rennerfelt furnace is built as a steel cylinder, with length and diameter practically equal. This cylindrical shell is supported on rollers or trunnions, and is furnished with one close-fitting charging and tapping door. The inside of the shell is covered with a layer of asbestos board, about 1¼ in. thick. Next to this is placed a lining of suitable first-quality firebrick. Against this rests the inner working lining of magnesite brick, fettled with a sintering composition of dolomite. Thus lined, the little furnace forms an egg-shaped melting vessel, withstanding a working temperature of above 2,000 deg. C. Centrally in the roof, and horizontally through gables or sides, enter water-cooled bronze electrode holders, through which slide, with a very neat fit, three Acheson graphite electrodes turned to exact size. The diameter of these electrodes varies from 1½ in. for the smallest up to 4 in. for the largest furnace above mentioned. Any available 3-phase current, preferably of 50 to 60 cycles, is converted in stationary transformers, by Scott's coupling, into 2-phase current at 70 volts pressure for the smallest, up to 90 volts for the largest furnace. One phase of current is coupled to each side electrode. The central vertical electrode is connected with the common point between the two phases of the transformer. When the current is turned on a pheno-

* Paper submitted for reading at the Autumn Meeting of the Iron and Steel Institute.

TABLE I.—*Record of Test Run—Melting and Storing of Ferro.*

Time.	Operation	Remarks.
P.M. 8.18	Charging begun	Temperature of furnace, 1588° C. 1000 kilogrammes of ferro, in cold lumps, were charged.
8.23	Charging completed.	
8.24	8 kilogrammes lime charged	For forming layer of slag covering metal.
8.30	Current turned on	115 volts per phase.

Time.	State of Kilowatt Hour Meter.	Units between Readings.	Kilowatts between Readings.	Remarks.
P.M. 8.30	170,084	..	..	Slight reddish smoke.
8.45	118	34	136	Melting proceeding quietly.
9.0	159	41	164	Smoke had disappeared entirely
9.15	200	41	164	
9.30	245	45	180	
9.45	287	42	168	
10.0	321	34	136	
10.18	379	58	193	
10.30	402	23	115	
10.45	444	42	168	
11.0	485	41	164	
11.15	525	40	160	Melting completed. Time for melting 1 ton of ferro, 2 hours 45 minutes. Expenditure of units per ton of ferro, 441 units. Average amount of current used, 160 kilowatts. If more power had been available the time of melting would have been reduced accordingly.
	Total	441		

11.15	Current shut off.	
11.16	250 kilogrammes cold ferro dropped into bath.	
11.18	Charging completed.	
11.19	Current turned on	Voltage, 95 per phase.

Time.	State of Kilowatt Hour Meter.	Units between Readings.	Kilowatts between Readings.	Remarks.
P.M. 11.19	170,825	..	..	
11.45	902	77	178	
12.0 midnight	646	44	176	Charge nearly melted.
A.M. 12.18	690	43	172	
12.29	703	14	168	Charge completely melted. Energy required, 440+178=619 units or 495 units per ton of ferro.
	Total	178		

Time.	Operation.	Remarks.
A.M. 12.32	Power cut off. 680 kilogrammes ferro cast	Run into sand beds. Temperature of furnace 1478° C
12.33	Power turned on	Voltage, 95 per phase.

Time.	State of Kilowatt Hour Meter.	Units between Readings.	Kilowatts between Readings.	Remarks.
A.M. 12.30	170,703	..	..	270 kilogrammes cold ferro charged.
12.36	723	20	..	
1.0	791	68	170	Charge almost all melted
1.15	836	45	180	
1.30	884	48	192	
1.40	913	29	174	Whole charge melted. It is probable that the melting was completed earlier.
	Total	210		

Time.	Operation.	Remarks.
A.M. 1.45	Current reduced	Energy required, 619+210=829 units, or 545 units per ton. Temperature of furnace, 1494° C. From 2.0 to 4.0 A.M. current at 90 volts was kept of the furnace. The following readings were made:—

Time.	State of Kilowatt Hour Metre.	Units between Readings.	Kilowatts between Readings.	Temperature
A.M. 2.0	170,944	..	..	..
2.15	962	18	72	..
2.30	..	..	..	..
2.30	978	16	64	1470°
2.45	995	17	68	1450°
3.0	1,011	16	64	1400°
3.15	1,025	14	56	1430°
3.30	1,038	13	52	1446°
3.45	1,052	14	56	1417°
4.0	1,069	17	68	1417°
	Total	125		

Time.	Operation.	Remarks.
A.M. 4.0	..	Power shut off. Test of very liquid metal was taken for chemical analysis.
4.20	..	Temperature of charge, 1494° C. No current on.
4.21	Metal cast in sand	Metal could not be properly weighed on account of lack of ingot moulds.
4.26	Furnace examined	Temperature of furnace, 1360° C. Furnace bottom found intact.

menon takes place. The arcs, instead of passing directly between the points of the electrodes, are deflected downward, forming an inverted arrow head or "fleur-de-lys," with a height of 6 to 12 in. When the bath has been formed in the furnace, the points of the electrodes are adjusted at such a height above the surface of the bath, that the point of the "arrow head" impinges on the surface of the metal, throwing out reddish waves of heat radiating towards the edges of the bath. When the furnace is to be preheated, the current is simply turned on, there being no necessity for solid fuel or metal in the furnace. The furnace can be charged and tapped with the current on the electrodes. The consumption of electrodes for melting ferro is from 2 to 3 lbs. per ton of metal. The electrodes are fed forward by small hand-wheel and rack mechanism as they are consumed. They are spliced by screw joints. The whole furnace is remarkable for its simplicity and compactness, and for the small and well-protected surface, in comparison with its cubic capacity, which it exposes to radiation.

The experiments in which I have been interested were made at the instance of the Elektriska Ugnar Company, Stockholm, owners of the Rennerfelt patents, with the consent and co-operation of the managers of the two works where the tests were made, namely, Mr. Amilon, managing director of the Hallstahammar Works, and Mr. von Eckermann, general manager to the Ljusne-Woxna Iron Company. The tests were personally supervised by Mr. Ivar Rennerfelt, the inventor of the furnace.

Test No. 1, *made at Hallstahammar Bolt and Nut Factory, Sweden, June* 11-12, 1914.

Capacity of furnace	1 ton to 1¼ ton.
Standard kilowatts	200.
Number of electrodes	Three Acheson graphite electrodes
Diameter of electrodes	3 inches.
Current supplied	2-phase, 50 cycles.
Voltage of current	Varying: 65, 80, 95, 110 volts.
Current received	3-phase, from generator 200 k.v.a., 400 volts, 290 amperes, driven by water turbine.
Transformers	Stationary, arranged with Scott's coupling. Voltage variable by primary adjustment. Transformers each of 125 k.v.a., 110 volts, efficiency being reduced according to voltage.

The furnace is usually employed for making steel castings and dead-soft steel ingots for special purposes. The voltage is usually regulated at 110 volts at the start, and 95 volts at the end of the charge.

The number of men employed when making steel is one melter and two boys per shift (five charges per twenty-four hours; two shifts).

After pouring the last charge of steel (from pig-iron and cold scrap, intended for making steel castings), the furnace was well cleaned out and fettled. Temperatures were taken by means of a Wanner optical pyrometer. Readings were made every fifteen minutes. The consumption of electrodes was ascertained by measuring the length of electrodes consumed from beginning to end of tests.

Oxidation.—During the first few minutes after charging, small reddish clouds of smoke escaped through the joint at top of door. Afterwards there was no sign of manganese smoke.

Consumption of Electrodes.—During the melting down of 1 ton of ferro as described above, the following consumption of electrodes was ascertained:—Top electrode, 16.5 centimetres; right-hand side electrode, 32.5 centimetres; left-hand side electrode, 12.5 centimetres. The excessive use of the right-hand side electrode was caused by the falling off of a defective piece of electrode near a joint. If a correction be made for this accident, the consumption of

electrodes would be $\frac{5.16 \text{ hours} \times 0.43 \text{ kg.}}{1.5 \text{ ton}}$ or 1.44 kg. per metric ton = say 3 lbs. per ton, which, at 6d. per lb. = 1s. 6d. per ton.

Chemical Analysis.—Analyses of ferro were made at the testing laboratory of the Royal Technical University, Stockholm, with the following result:—

	Before melting.	After melting.	Loss.	Gain.
			Per cent.	Per cent.
No. of test	93,541	93,542	—	—
Weight	220 grammes	65 grammes.	—	—
Carbon	6.07 per cent.	5.69 per cent.	0.42	—
Manganese	78.90 ,,	79.50 ,,	—	0.60
Iron	11.70 ,,	12.30 ,,	—	0.60

Cost of Melting.—Assuming the cost of electric current to be ¼d. per unit, which is a safe figure for most steelworks, the cost of melting of ferro in the Rennerfelt electric furnace, poured off hot into the receiver after melting, would be, per ton:—

	s.	d.
Loss of ferro, assumed, 1 per cent. at £11 ..	2	2
3 lbs. of electrodes at 6d.	1	6
Repairs, from experience	1	3
Royalty, average	3	6
Current, 441 units at ¼d.	9	2
Depreciation, 15 per cent.	3	9
Labour, 1 man per shift	3	8
Cost of melting 1 ton ferro	25	0

For a steel plant producing 300,000 tons of steel per year:—

Gross cost of ferro saved at £11 per ton ..	£5,260
Less—cost of melting 1,920 tons ferro at 25s.	2,400
Net saving per year	£2,860

This saving is a minor consideration as compared with the great advantage gained by the uniform distribution of the manganese in the steel, resulting in higher quality of product.

Results.

By the above tests the following points have been established:—

(1) That the melting of one ton of ferro, charged into an empty and pre-heated Rennerfelt furnace, requires less than 450 (441) units. The corresponding efficiency of the furnace is 78 per cent. to 79 per cent.

(2) That the melting of one ton of ferro, if dropped into an existing liquid bath in the furnace, will require less than 750 (average 741) units, the corresponding efficiency of the furnace being 47 per cent.

(3) That the keeping hot of one ton of liquid ferro in the electric furnace during one hour at constant temperature requires less than 80 (77) units, or about 30.5 per cent. of the regular power consumed by the furnace when melting.

To corroborate the results of tests No. 1 similar tests were made at the Ljusne Works of the Ljusne-Woxna Iron Company, Sweden. The furnace employed was a Rennerfelt tilting furnace, with a capacity of 10 to 11 cwts. charge, and arranged for 125 kw. of current. It is equipped with three Acheson electrodes, 2 in. in diameter, and is insulated in the same manner as the furnace at Hallstahammar. The lining was new, the bottom being built up of magnesite, the roof of "Dynamidon" brick. This furnace has been running for about fifteen months, making a splendid record on special steels and steel castings.

TABLE II.—*Test No. 2—June 15, 1914.*

Time.	Operation. State of Units Meter.	Units between Readings.	Kilowatts between Readings.	Remarks.
P.M.				
6.40	Charging begun	...	...	Furnace at yellow heat.
7.00	25370	...	...	385 kilogrammes ferro charged.
7.15	390	20	100	
7.30	418	28	100	
7.45	443	25	100	
8.00	466	23	100	
8.15	491	25	100	108 kilogrammes ferro added.
8.30	518	27	110	
8.45	540	22	100	13 kilogrammes ferro tapped; furnace
9.00	565	25	110	bottom too high.
9.15	590	25	110	Melting completed.
	Total units.	220		493 kilogrammes total charge.

Ferro melted .. .. .. 493 kg.
(Time, 2 hours 35 minutes.).
Units per ton of ferro 446
Efficiency of furnace .. .. 78.2 per cent.
Ferro recovered—
Drawn from furnace .. .. 13 kg.
,, ,, ladle .. .. .. 465 ,,
Lost in ladle .. .. .. 5 ,,
Total .. .. 483 kg.

The loss in melting was 2.03 per cent. The high percentage of loss is due to:—(1) The fact that no slag was made to cover the surface; (2) to the entirely new lining, any porosity or cracks in which would be filled with ferro; (3) to the small size of the furnace, which causes a small loss in weight to figure as a high percentage.

Electrodes consumed: 360 grammes actual weight.
Electrode consumption: $360 \times \frac{1000}{493} = 0.73$ kg., or 1.63 lbs. per ton of ferro melted.

The test was discontinued on account of trouble in power station.

For test No. 3 the same furnace was used as for test No. 2. The immediately preceding heat produced regular steel for castings. The furnace was carefully cleaned and fettled.

TABLE III.—*Test No. 3.—Ljusne Works, July 1, 1914.*

Time.	State of kilowatt-hour meter.	Units between readings.	Kilowatts between readings.	Remarks.
0.00	—	—	—	450 kg. ferro charged current turned on.
1.55	184	184	110	Melting completed.

Units—total 184
Ferro melted .. .. 450 kg.
(Time, 1 hour 55 minutes).
Units per ton 409
Efficiency of furnace .. .. 85.5 per cent.

Note.—This abnormal efficiency must be partly ascribed to high initial heat of the furnace, due to it just having melted a charge of steel.

During two hours and fifty minutes the charge was kept molten in the furnace, and greatly superheated. At the end of a total time in furnace of four hours and forty-five minutes, during which 100 kg. of ferro were tapped and 100 kg. of cold ferro were added, the heat was poured, showing the following results:—

Metal recovered 543.8 kg.
Loss, 6.2 kg., 11.4 kg. per ton, or 1.14 per cent.
No slag had been made to protect this bath.
Consumption of electrodes by weighing, 800 grammes.
,, ,, ,, per hour, 180 ,,
,, ,, ,, per ton melted and kept liquid during 2 hours, 50 minutes, 767 grammes, or 1.7 lbs.

Analyses.—The ferro was analysed at the Ljusne Works laboratory, as follows:—

	Manganese.
Ferro before charging	80.1 per cent.
Ferro after melting	79.0 „

The loss in ferro is explained by the absence of any protecting slag on top of the bath.

Loss of Manganese.—In test No. 1 this could not be ascertained, because there were no moulds available in which to collect the ferro. Analyses indicate that no oxidation of manganese took place, the bath being protected by a limey slag.

In test No. 2 the newly lined furnace showed a loss of ferro of 2.03 per cent. for melting only. In this case the bath was unprotected, and if the porosity and cracks in the furnace lining absorbed only 5 kg. of metal this loss would have been brought down to 1 per cent.

In test No. 3 the loss of metal in melting and keeping molten in a superheated state during 2 hours 50 minutes after complete melting resulted in a total loss of metal of 1.14 per cent.

In regular practice and with furnaces running continually on ferro, the bath being protected by a small quantity of basic slag, it is therefore justifiable to assume a loss in melting of only 1 per cent. of the metal charged.

Conclusions.

(1) The high efficiency of the Rennerfelt furnace as a melter depends on the excellent insulation of the furnace, the tightness of the door, the absence of all air inlets, the effective arrangement of the small electrodes, and on the heat arcs produced by them.

(2) The comparatively low efficiency of the same furnace for melting additional charges dropped into the liquid bath depends evidently on the indirect heating of the solid lumps of ferro and the stopping of circulation in the bath around the cold metal.

(3) The Ljusne tests No. 2 and 3, in a small furnace, corroborate the excellent melting results obtained in Hallstahammar test No. 1. The size of furnace has not influenced the economy. The fact that more ample power was available during tests Nos. 2 and 3 accounts for the greater efficiency of the furnace.

(4) The absence of oxidation of the metal, even if kept during long periods in the Rennerfelt furnace, and greatly superheated, has been proved, especially if the bath be protected by a thin sheet of basic slag.

(5) In order to get the best results, the furnace must be used only as a melter of ferro, exposed directly to the heat rays. The metal, as soon as melted, should be removed from the furnace into a ladle or into a receiver. Better results in remelting will undoubtedly be secured if the ferro be added in small quantities broken into small lumps well scattered in the bath. But the best economy will be reached by either of the two methods, A. or B., described below.

A. Direct Method (Fig. 1).—This involves building inside the furnace, in front of the charging and tapping door, a small bridge or platform of magnesite brick. The top level of this platform should be slightly below the level of the liquid bath when the furnace is charged. The cold ferro should be placed on this bridge, in close proximity to the heat arcs, the lumps of ferro being exposed to them. To the users of the Rennerfelt furnace this offers a simple and inexpensive expedient, which is bound to maintain the economy indicated by the first melting. It is suitable for works in which the ferro is required frequently, regularly, and in small quantities.

B. Indirect Method (Fig. 2) shows an arrangement applicable in many works. By "indirect method" I intend to convey the idea of one or two small ferro-melting furnaces delivering charges, as quickly as melted and slightly superheated, into one bottle-shaped, tightly-closed, heavily-lined, and well-insulated tilting receiver, placed on a small truck running on a track on the casting floor level below the ferro furnaces, and so placed that the metal can be poured directly from the melting furnaces into the throat of the receiver. When not receiving charges the receiver is placed between the two furnaces in front of a weighing scale supporting the ferro-distributing ladle. When the receiver is in an upright position, the nock is closed by a heavy plug of fire-brick, operated by the weighman from his position near the scale.

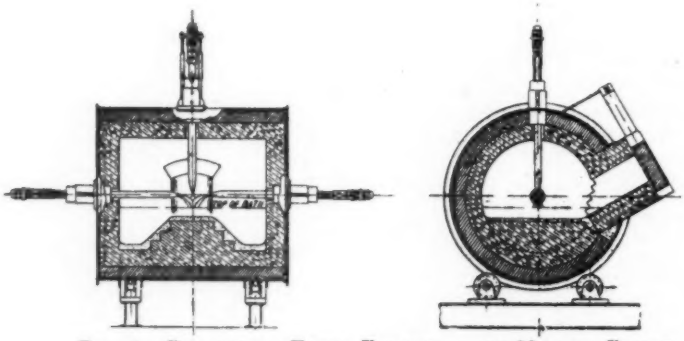


FIG. 1.—RENNERFELT FERRO FURNACE, WITH MELTING BRIDGE.

For preheating the receiver, and eventually to supply additional heat in emergencies, a small oil burner should be fitted in the side of the neck. During continuous operation this will, however, never be required, as the superheat of the ferro drawn from the Rennerfelt furnace is sufficient to maintain liquid during several hours the metal stored in the receiver.

Under the steelworks' casting crane girder, and along the front of the supporting columns, should be suspended a mono-rail on which will travel a hoist larry carrying the small ferro ladle. This ladle should be designed to be of sufficient capacity to take the largest charge of ferro required for any heat produced. When it has been filled from the receiver, the ladle is lifted by the hoist and moved along the mono-rail until it arrives directly above the tapping trough of the furnace from which the heat is

to be taken. When the ladle is raised to a certain height above the furnace tapping trough, a tipping hook suspended from the trolley automatically attaches itself to the bottom of the ladle. If now the ladle is lowered by the hoist operator, it will gradually be emptied into the tapping trough, the ferro mixing with the steel as it flows from the furnace. If desired, the ferro can also, by the same arrangement, be poured directly into the casting ladle.

This method is recommended for large steelworks making heavy heats. For such works it is also better to work two small ferro furnaces having together the safe capacity required, and so operated that heats are tapped from them alternately, rather than to rely on one larger furnace. Whether one or two furnaces are employed, a spare furnace shell should be kept as a reserve, lined and ready for use.

(6) The ferro-melting furnace should be chosen as small as practicable to ensure a regular supply of liquid ferro when required. The following sizes of furnace are recommended for plants running regularly, subject to revision in case of special requirements:—

For steelworks producing up to—	Furnace capacity.
75,000 tons per year ..	6 cwts (300 kg.).
200,000 „ „ „ ..	12 „ (600 kg.).
300,000 „ „ „ ..	18 „ (900 kg.).
400,000 „ „ „ ..	25 „ (1,250 kg.).
500,000 „ „ „ . One	36 „ (1,860 kg.).
or two	18 „ (900 kg.).

(7) The similarity of the figures obtained with two furnaces of different size, run by different men and under different conditions, gives assurance of the practical trustworthiness of the results obtained.

(8) These experiments indicate an economical method of melting ferro for the steel processes.

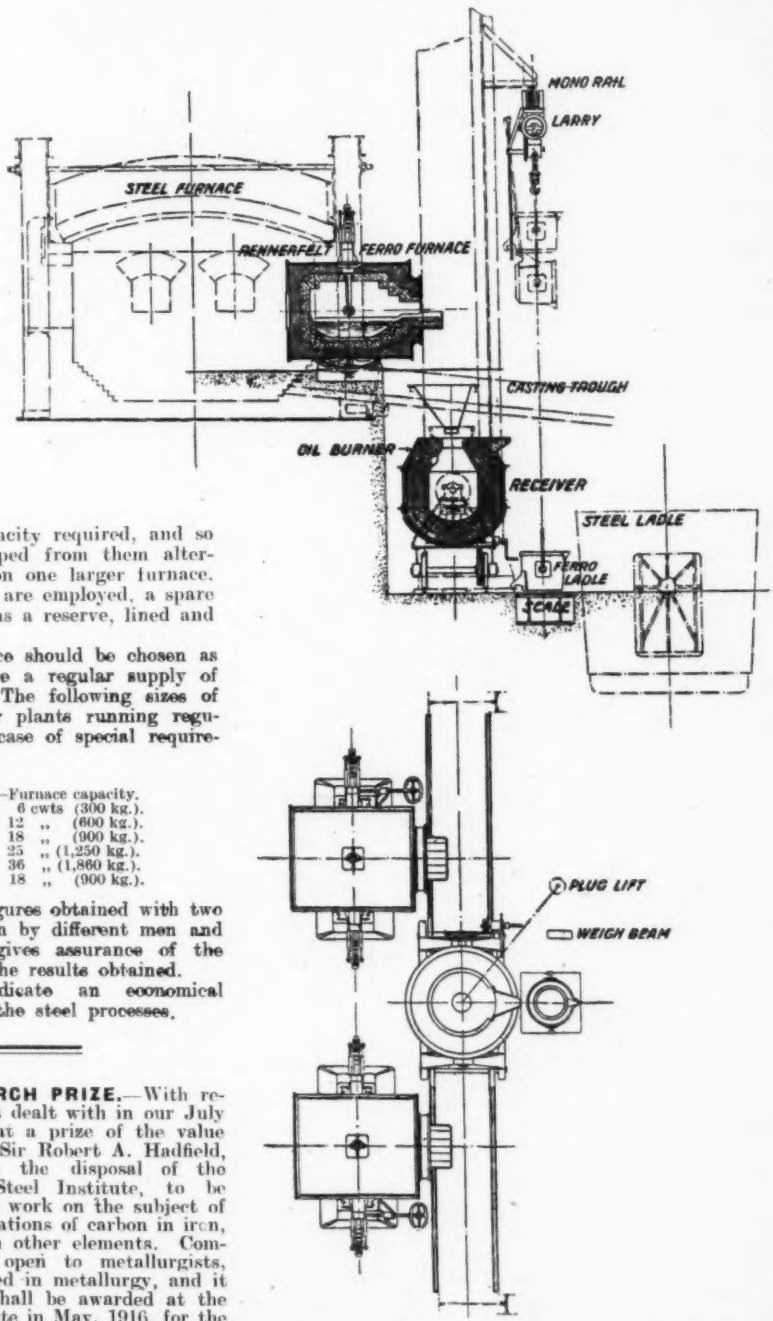


FIG. 2.—RENNERFELT FERRO FURNACES WITH RECEIVER.

THE HADFIELD RESEARCH PRIZE.—With regard to this prize, which was dealt with in our July issue, it may be recalled that a prize of the value of £200 has been placed by Sir Robert A. Hadfield, F.R.S., Past President, at the disposal of the Council of the Iron and Steel Institute, to be awarded for original research work on the subject of the different forms or combinations of carbon in iron, steel, and alloys of iron with other elements. Competition for the prize is open to metallurgists, chemists and others interested in metallurgy, and it is proposed that the prize shall be awarded at the annual meeting of the Institute in May, 1916, for the best report presented before February 1, 1916. Sir Robert Hadfield is also prepared to offer a second prize for the report next in merit to the one which gains the first prize, provided it is adjudged to be a really meritorious paper. It is not desired to limit the scope of the research too closely, but it is suggested that the work should be in continuation of, or based upon, the work of previous investigators. The object is to stimulate the study of carbides in iron and iron alloys generally, also with a view to discovering the best method of determining the forms and combinations in which carbon occurs in iron and steel. Intending competitors should communicate, in the first place, with Mr. G. C. Lloyd, Secretary of the Iron and Steel Institute, 28, Victoria Street, London, S.W.

Strength and Ductility of Malleable Cast Iron after Removal of the Skin.*

By Enrique Touceda.

The object of this Paper is to contradict the statement frequently made, that after the skin of a malleable casting has been removed, the remaining metal is of inferior quality, if not absolutely worthless.

It is a well-known fact that the softest and most ductile constituent in any iron product is ferrite, carbonless iron. If, under the microscope, in the structure of a specimen of iron or steel that has been properly polished and etched, it is seen that ferrite predominates, it can be predicted that the material from which the specimen was taken is soft and ductile, directly in proportion to the amount of ferrite present. If the structure is wholly ferrite, and this is uncontaminated by slag or free carbon, it can be predicted that the metal is of maximum softness and ductility.

The structure of good wrought iron consists practically of ferrite, due to its containing but an inappreciable amount of carbon, but the uniformity of the structure, as can be seen by reference to the photo-micrograph, Fig. 1, is somewhat interfered with by the presence of slag particles that cannot be entirely removed from the iron during the process of manufacture. Commercial wrought iron is both soft and ductile, and its structure consists practically of ferrite, throughout which are irregularly distributed particles of slag, so that if we obtain some other product of similar structure, aside from the fact that for the particles of slag there is substituted some other impurity equally inert, we should logically expect to have a product of similar physical qualities.

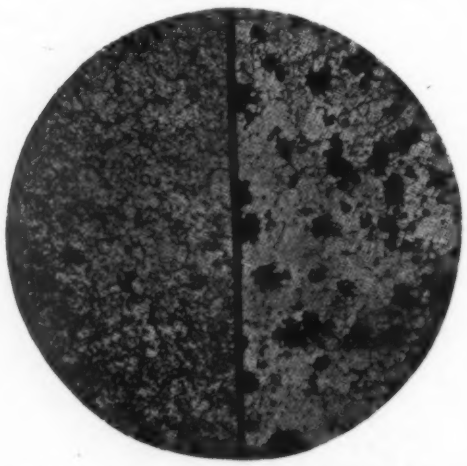


FIG. 1.—MICRO-PHOTOGRAPH OF CROSS SECTION OF WROUGHT-IRON BAR.

FIG. 1A.—MICRO-PHOTOGRAPH OF CROSS SECTION OF MALLEABLE CAST-IRON BAR.

Briefly the malleable iron process consists first, in melting in an air furnace a properly proportioned mixture of grey pig-iron and sprues from some previous heat, and refining the bath until enough silicon has been removed from the iron to force all of the carbon to remain combined in the resultant product, so that iron in the castings will be white, with the accompanying hardness and brittleness incident to that condition; second, the placing of these castings in iron pots, where they are surrounded with an oxidising packing, the pots being then placed in ovens to be heated to redness for numerous days. Through this heat treatment the extremely hard carbide of iron of the white iron casting is broken up into two very soft constituents, carbonless iron (ferrite), and free carbon which contaminates it; while coincident with this transformation some of the carbon is removed from the casting, both factors serving to convert the hardest possible product into one of the very softest.

The structural composition of properly annealed malleable iron is made up wholly of ferrite, but with the exception of the ferrite in the rim, all of this constituent is contaminated with more or less free carbon, the preponderating amount of ferrite containing but very little, and the lesser amount containing it in highly concentrated form, these carbon patches, as they can be appropriately called, being uniformly distributed throughout the area of the section, as can be seen by reference to Fig. 1A.

In short, with two exceptions, if the slag of wrought iron and the free carbon of malleable iron be left out of consideration, the structural composition of wrought iron and malleable iron are identical. One of the exceptions is that the ferrite of the malleable iron is higher in silicon than that of the wrought iron; but such an amount of silicon as may be found in commercial malleable iron does not render the ferrite less ductile, nor does it have an influence to render the crystallisation more coarse. This, then, can be set aside as having no bearing on the case. The other exception results from the presence in the ferrite of the contaminating free carbon, which is present in too small an amount in a great part of the ferrite to affect its true physical properties to any appreciable extent, but which I anticipate must lessen its strength and ductility where it occurs in the ferrite in concentrated form, as shown in the patches referred to.

If the two steps in the malleable-iron process have been properly conducted, even if in a casting there be a section 3 in. square, it will be found that the structure of this section is uniform throughout.

With regard to the so-called skin of malleable-iron castings, if the annealing process has been arrested at the exact moment when the last trace of free or pearlitic cementite in the casting has been broken up into ferrite and free carbon, there will be seen under magnification, around the edge of the casting a rim about 1/32 in. deep of practically carbonless iron, due to the perfect elimination of the carbon to this depth. As a matter of fact,

* Abstract of paper read before the American Foundrymen's Association, Chicago Convention, 1914.

such a rim exists in any piece of rolled steel or steel casting. The structure in the balance of the section is very uniform throughout, except that the patches of concentrated carbon increase slightly in size as the centre of the section is approached, the increase being very slight indeed.

If we now take a ¾-in. round test bar, and calculate the area remaining after the rim has been machined off, and then the area of the metal in the rim, it will be found that the first amounts to 0.442 sq. in., while the latter amounts to 0.07 sq. in., the metal in the rim being 15.8 per cent. of that in the "core," as the rest of the metal is sometimes designated.

It has been pointed out that the structural composition of the rim as a rule is ferrite, uncontaminated with free carbon, and it is a well-known fact that annealed ferrite will not exceed in strength more than 50,000 lbs. per sq. in. If the amount of metal in the rim is but 15.8 per cent. of that of the rest of the bar, its strength would have to be very much higher than the strength of annealed ferrite in order to bring the strength of the bar as a whole to 41,000 lbs. per sq. in., the average strength of commercial malleable iron. Assuming for the sake of illustration that the metal remaining after the rim has been machined off will stand 30,000 lbs. per sq. in. (which is certainly far from being worthless material), the metal in the rim must stand as high as 98,838 lbs. per sq. in. in order to bring the bar as a whole to a strength of 41,000 lbs. Also 98,838 lbs. per sq. in. corresponds to the strength of a 0.50 per cent. carbon steel. If the statement is correct that after the rim has been removed the remaining material is very inferior and lacks ductility, then the figure of 30,000 lbs. per sq. in. above assumed is too high, and the metal in the rim must be called upon to stand a strength in excess of 98,838 lbs. per sq. in., that is, a strength equal to a 0.60 per cent. carbon steel.

An elongation of 10 per cent. in 8 in. is by no means uncommon in good malleable cast iron, and if the above remarks on the relative strength of the metal in the rim and core do not make the statements under criticism absurd enough, let us dwell for a moment on the condition that must exist in a malleable test bar that yields an elongation in 8 in. of 10 per cent.

It is conceivable, and a fact that must be acknowledged, that a rim of metal having a strength in excess of that in the core, can add greatly to the final strength of the bar; but how can the metal in the rim affect the elongation, unless its ductility be less, not greater, than the metal in the core? If it be of less ductility, then it will start to check as the limit of its capacity to stretch without fracture is reached, and the metal in the core will continue to stretch until the bar breaks; but if, as is claimed, it is more ductile than the metal in the core, then the metal in the core will stretch until it can no longer do so but instead breaks, and that in the rim likewise, for obvious reasons, though it must be admitted that the metal in the rim had not at the time reached the limit of its capacity to stretch.

If this reasoning be correct, any record of elongation on a malleable cast-iron test bar expresses in exact terms the elongation of the metal in the core only, as the metal in the rim is capable of further stretch. Records of elongation then, on malleable cast-iron test bars are a direct measure of the ductility of the metal in the core of the bar.

The contention that the core is of such inferior quality probably results from the use of test bars of a defective character. The writer has noticed that defects nearly always exist in bars such as are usually made for tensile tests, due to unsoundness caused by shrinkage, or faulty contraction, as the case may be. Such defects obviously are in the majority of cases located at the centre of the section of the bar, and nearly always at the central region of the bar's length. Many test bars are made with a reduced section, for the double purpose of enabling the grips of the machine to better hold the specimen, and of forcing the bar to break outside the grips. A bar cast in this manner is nearly always defective, due to the inability of the iron to set normally. First there is the liability of shrinkage at the fillet, and second there is the fact that the tightly-packed sand around the reduced section of the bar prevents the normal setting of the molecular structure in the region of the centre of its length.

Further, when experiments are made to determine the difference in strength between skin and core, by the time the finishing cut is made at least 1/16 in. of the stock has been removed all around the bar, and this represents 30 per cent. of the original area, and at times more is removed under the belief that the skin exceeds this amount in depth. If the region around the central portion of the test bar is unsound, due to any cause, what chance is there of arriving at correct conclusions as to the relative strength of metal in skin and core?

If there is any reason why there should exist a great difference in strength between the metal of the skin and of the core, surely there should be seen some tangible evidence under the microscope. When

FIG. 2.—TEST WEDGES OF MALLEABLE CAST IRON.

such cases happen in steel or grey iron, the microscope immediately makes manifest the cause, and there is no difficulty whatever in making plain the reason for the alteration in strength, as there will be seen a difference in grain-size between the parts, in structural composition, in unsoundness or oxides.

In order to go further into this matter, the writer has made some physical tests, conducted under conditions of extreme severity as compared with the regular tensile test. The form of the test bar is a wedge 1 in. wide throughout and 6 in. long; ½ in. thick at the base, and tapering to 1/16 in. at the top. This wedge, when tested under a specially designed test hammer, has its thin end first bent slightly over by hitting it a few light blows with a hand hammer for the purpose of facilitating the curling up of the bar when it is subsequently placed on the anvil of the test hammer to be struck repeated blows until fracture takes place. In testing the bar, it is held upright on the anvil, when the hammer weight, delivering a seventy foot-pound blow, is allowed to fall on it. If the metal is ductile and strong it will curl up more and more until failure takes place, and the number of blows required to produce fracture and the amount of the curl become a direct measure of the strength and ductility of the metal. In Fig. 2 can be seen four such test wedges that have been struck repeated blows, the blows being stopped the moment it was seen that fracture had commenced.

A pattern was made for a wedge of the above dimensions, and another was made of the same length and width, but ⅛ in. thick at the base, and 3/16 in. at the other end. When 1/16 in. of metal is planed off of the two 1 by 6 in. faces of the latter wedge, one is obtained that corresponds exactly in size with the other, so that through the aid of these two patterns, and the machining of the larger as described, wedges of the same dimensions are obtained, one with the skin on and the other with 1/16 in. of the surface metal removed.

The following are the results of the tests, the weight delivering a blow of seventy foot-pounds when the wedge starts to curl, and a slightly greater force after each succeeding blow :—

Heat No. 1.

Unmachined wedges.	Machined wedges.
Average of 4 tests.	Average of 4 tests..
18.5 blows.	13.2 blows.

Heat No. 2.

Unmachined wedges.	Machined wedges.
Average of 4 tests.	Average of 4 tests.
29.75 blows.	26.3 blows.

Heat No. 3.

Unmachined wedges.	Machined wedges.
Average of 4 tests.	Average of 4 tests.
19.75 blows.	21.2 blows.

Here is seen one case where the machined wedges actually stood a better test than the ones with the skin on, but setting this aside as unusual, which I believe would prove to be the case, can anyone state after the physical tests herewith presented that malleable cast iron with absolutely all its skin removed is neither ductile nor trustworthy? The three machined wedges shown in Fig. 2 have stood 24, 24 and 21 blows of seventy foot-pounds respectively.

One reason for the selection of this type of bar for the test was that, as calculation will show, after 1/16 in. has been machined from each side of the wedge, about 20 per cent. of the stock has been removed from the base; about 66 per cent. from the thin end section, and about 26 per cent. at the section where failure usually takes place. This is testing the core of the metal with a vengeance. These wedges were cast from regular iron as made from day to day, and they received no treatment other than what the regular run of commercial castings made at the plant are given. The writer has individual cases of machined wedges that have stood as high as 29 blows. Some cast-steel wedges cast from the same pattern as that from which the malleable cast-iron ones were made, stood 19, 21 and 23 blows respectively, when tested in exactly the same manner.

In conclusion I would state that good malleable castings possess virtues that have not received the recognition they deserve when their unique characteristics are considered. When cheapness, soundness, ease of machining, freedom from blow-holes, ability to stand abuse in service, and marked stiffness combined with ductility are considered as a whole, the malleable-iron casting has no competitor.

A GENERAL discussion on "The Hardening of Metals" took place by the members of the Faraday Society at a meeting held on Monday, November 23, at the Chemical Society, Burlington House, London, W. The president, Sir Robert Hadfield presided and among those who took part in the discussion were Professor Ernest Cohen (of Utrecht), Dr. G. T. Beilby, Professor J. O. Arnold, Professor H. C. H. Carpenter, Dr. C. H. Desch, Professor C. A. Edwards, Mr. H. L. Heathcote, Mr. J. C. W. Humfrey, Dr. T. M. Lowry, Mr. Andrew McCance, and Dr. W. Rosenhain.

Erecting Roots Blowers.

The following interesting instructions are included in a catalogue issued by Messrs. Alldays & Onions' Pneumatic Engineering Company, Limited:—

The blower should be mounted on a solid foundation, for which brickwork or concrete is recommended as the most suitable material, though heavy timber, well framed together, is a good arrangement. The blower to be installed should be taken off its bedplate, the latter placed in position, and the foundation bolts tightened up. The bedplate should be allowed to set before the blower is put to work. The facings on the bedplate should be tested with a long straight-edge and spirit level to see that they are level and in the same plane. If there is a fault in this direction, then the foundation bolts should be loosened, and packing inserted under the corresponding edges until the alignment is quite true. The blower shafts must be set perfectly level in the length and width.

Lubrication must not be neglected. Bearings and gear wheels, where all the friction in the blower exists, must be carefully attended to. The gear box should be partly filled with grease or heavy oil. Only cast-iron or wrought-iron blast piping should be adopted. No reliance can be placed on brick culverts or earthenware piping, which are absolutely unfit for foundry use. Air-tight pipes and joints are necessary to ensure the full efficiency from the blower.

The adjustment of the bearings should receive careful attention. The Company's conical adjustable bearings consist of gun-metal taper bushes fitted into similarly shaped bosses on endplates and end standards, and prevented from revolving by a sunk key. When adjustment is required, thin wrought-iron lock rings are slackened back, and the cast-iron nuts very carefully screwed up, until the shafts can be easily pulled round by hand, the wrought-iron lock ring being then finally tightened securely. No undue slip should be allowed on the belts, and in case of driving from each end of the blower, one belt should run open, the other being crossed, each being in equal tension. It is necessary for cupolas, where the blast is intermittent, that an escape valve be fitted near the blower, so as to allow any surplus air to escape when part or all of the blast is turned off, thus maintaining a uniform pressure. If a blower is installed in a dusty atmosphere, it should be covered in with a wooden shed with a perforated opening for the admission of air.

COPPER IN THE FUTURE.—Since the commencement of the 20th century nearly eight million tons of copper has been extracted from the ores, and been consumed in the chief manufacturing countries of the world. The value of this metal, at an average price of £60 per ton for the whole period, is £480,000,000. How long can the earth continue to supply this amount of copper, or to keep pace with the increasingly rapid growth in the demand for the red metal? It would certainly seem probable that within the next twenty years the "known" ore reserves of the existing mines will be largely worked out, and that unless new ore deposits of vast extent are discovered, copper will become one of the rarer and more costly metals before half the century has passed away. However, by that time some other metal or alloy will have been found to serve the purposes for which copper is now used, and the disturbance and inconvenience caused by the rise in the price of copper will be reduced to a minimum by the change from copper to some other metal. Will that metal be aluminium?

The Transverse Testing of Cast Iron.

By George Hailstone.

The object of this Paper is to suggest the cast-iron test-bar that should be used to obtain the most reliable and consistent results with breaking load and deflection, also the relation that exists between the two English standard test-bars. Some specifications give the contractor the option which test-bars he shall cast, namely, the bar 2-in. by 1-in. section tested on 36-in. centres, or the 1-in. square bar tested on 12-in. centres. According to a typical specification, the 1-in. square bar tested on 12-in. centres is required to stand three-quarters of the load of the 2-in. by 1-in. section bar tested on 36-in. centres.

Professor Turner states that "For transverse tests many shapes and sizes of test-bar have been adopted, and, for scientific purposes, the results so obtained are converted by calculation into values for a bar 1-ft. long and 1-in. square. The common test-bar in use by founders is 3 ft. long, 2-in. deep, and 1-in. broad. By multiplying cwts. recorded with such a bar by 84, the results may be converted into lbs. on the standard bar. Or, conversely, divide lbs. on the standard bar by 84 to obtain cwts. on the ordinary 3-ft. bar."

Calculation on this basis shows the breaking load of a cast-iron bar 2-in. by 1-in. in section tested on 36-in. centres is 1.333 times as great as a 1-in. by 1-in. bar tested on 12-in. centres. The author has made a series of tests, the results of which do not appear to bear out this relation.

The material used in this investigation was cast iron of fairly good quality, but of the non-chilling

TABLE I.—*Test Bars A, B, C, and D, Machined to 2 in. by 1 in. in Section, and Tested on 36-in. Centres.*

Load in Cwts.	Test-Bar "A," Deflection in Inches.	Test-Bar "B," Deflection in Inches.	Test-Bar "C," Deflection in Inches.	Test-Bar "D," Deflection in Inches.
3	...	...	...	...
4	0·011	0·009	0·013	0·011
5	0·023	0·020	0·033	0·022
6	0·035	0·033	0·035	0·033
7	0·049	0·044	0·047	0·045
8	0·061	0·056	0·060	0·058
9	0·074	0·070	0·073	0·070
10	0·087	0·091	0·086	0·084
11	0·101	0·095	0·100	0·095
12	0·115	0·108	0·112	0·108
13	0·130	0·121	0·125	0·122
14	0·143	0·135	0·141	0·137
15	0·162	0·149	0·154	0·150
16	0·173	0·164	0·168	0·165
17	0·188	0·179	0·183	0·180
18	0·205	0·193	0·200	0·193
19	0·221	0·211	0·216	0·213
20	0·237	0·227	0·234	0·229
21	0·255	0·242	0·249	0·246
22	0·273	0·261	0·267	0·264
23	0·292	0·279	0·286	0·283
24	0·312	0·299	0·305	0·303
25	0·331	0·317	0·326	0·323
26	0·352	0·340	0·347	0·346
27	0·373	0·362	0·371	0·369
28	0·396	0·387	0·396	0·395
29	0·415	0·408	0·420	0·421
29·5	Test-bar broken	Test-bar broken	Test-bar broken	Test-bar broken
30		...	...	...

TABLE II.—*Test Bars AA and BB.*

Machined to 1 inch by 1 inch in Section, and tested on 12-inch Centres.

Load in Cwts.	Test-Bar AA, Deflection in Inches.	Test-Bar BB, Deflection in Inches.
5	...	...
6	0·001	0·002
7	0·004	0·006
8	0·009	0·010
9	0·013	0·014
10	0·018	0·018
11	0·022	0·023
12	0·026	0·028
13	0·031	0·032
14	0·036	0·037
15	0·041	0·042
16	0·047	0·049
17	0·052	0·055
18	0·058	0·061
19	0·064	0·068
20	0·070	0·074
21	0·078	0·083
22	0·085	0·092
23	0·091	0·101
24	0·102	0·112
25	0·109	Test-Bar Broken.
25·75	Test-Bar Broken.	..

TABLE III.—*Test Bars AAA and BBB.*

Machined to 1 inch by 1 inch in Section and tested on 24-inch Centres.

Load in Cwts.	Test-Bar AAA, Deflection in Inches.	Test-Bar BBB, Deflection in Inches.
1	...	...
2	0·006	0·010
3	0·032	0·038
4	0·061	0·059
5	0·089	0·087
6	0·122	0·117
7	0·155	0·150
8	0·196	0·187
9	0·239	0·228
10	0·288	0·277
11	0·344	0·333
12	0·414	0·403
12·5	...	0·445 Test-bar broken.
13	0·475 Test-bar broken.	... ...

TABLE IV.—*Test Bars CC and DD.*

Machined to 1·5 inch by 1 inch in Section and tested on 24-inch Centres.

Load in Cwts.	Test-Bar CC, Deflection in Inches.	Test-Bar DD, Deflection in Inches.
4	0·0015	0·005
5	0·009	0·014
6	0·017	0·023
7	0·026	0·032
8	0·034	0·041
9	0·042	0·051
10	0·052	0·059
11	0·060	0·069
12	0·069	0·078
13	0·080	0·088
14	0·089	0·098
15	0·100	0·109
16	0·111	0·120
17	0·123	0·133
18	0·136	0·146
19	0·148	0·159
20	0·161	0·174
21	0·176	0·190
22	0·191	0·206
23	0·206	0·224
24	0·223	0·245
25	0·240	0·266
26	0·260	0·291
27	0·281	0·312
28	0·310	0·331
28·6	...	0·352
29	0·335 Test-bar broken.	Test-bar broken. ..

* Abstract of Paper submitted for the Autumn Meeting of the Iron and Steel Institute.

type, melted in the cupola. Two sets of two test-bars, 2½ by 1½ in. in section, and 50 in. long, were poured from the same ladle in immediate succession. The bars were cast in green-sand moulds horizontally, the down and in gates being of the same size in each case. After casting, the bars were allowed to stay in the sand until the following morning, when they were fettled and machined down to 2 in. by 1 in. in section, and marked A, B, C, and D. A and B were cast in one mould, and C and D in the other.

TABLE V.—*Actual Relation between Cast-iron Test Bars 2 in. by 1 in. in Section, Tested on 36-in Centres, and Test Bars 1 in. by 1 in. in Section, Tested on 12-in. Centres.*

Cast iron test-bars machined to 2 inches by 1 inch in section and tested on 36-inch centres, one of the broken halves then machined to 1 inch by 1 inch in section and tested on 12-inch centres.

Breaking Load in Cwts.		Difference in Cwts.	Ratio of 2-inch by 1-inch Bar tested on 36-inch Centres to 1-inch by 1-inch Bar tested on 12-inch Centres.
2-inch by 1-inch Bars tested on 36-inch Centres.	1-inch by 1-inch Bars tested on 12-inch Centres.		
23·00	20·00	3·00	1·150
23·25	20·25	3·00	1·148
24·00	20·75	3·25	1·156
24·25	21·00	3·50	1·154
24·50	21·00	3·50	1·166
25·00	21·50	3·50	1·162
25·50	22·00	3·50	1·159
26·00	22·75	3·25	1·142
26·50	23·00	3·50	1·151
27·75	24·00	3·75	1·156
28·00	24·25	3·75	1·154
28·75	25·00	3·75	1·150
29·00	25·25	3·75	1·148
29·75	25·75	4·00	1·154
30·00	26·00	4·00	1·151
30·50	26·25	4·25	1·161
30·75	26·50	4·25	1·160
31·25	27·00	4·25	1·157
31·75	27·50	4·25	1·154
32·00	27·75	4·25	1·153
32·25	28·00	4·25	1·151
33·25	29·00	4·25	1·146
33·50	29·00	4·50	1·155
34·00	29·75	4·25	1·142
34·50	30·00	4·50	1·150
35·00	30·50	4·50	1·147

Mean ratio of 2-inch by 1-inch bar, tested on 36-inch centres, to 1-inch by 1-inch bar tested on 12-inch centres, equals 1·153 times the breaking load.

The test bars A, B, C, and D were tested in the following manner on 36-in. centres:—Each bar was placed in the machine, and the hand wheel of the straining screw rotated until the test-bar was rigid. The deflection scale was set at zero, and the poise propelled until the steelyard was just floating as observed from the position of the index fingers, when the first load reading was taken and recorded. The poise was then propelled another cwt., the steelyard brought into equilibrium again, and the deflection taken; a further cwt. load was put on the test-bar, the steelyard again brought into equilibrium, and the deflection taken, and so on cwt. by cwt. until the bar finally fractured. The load was applied in each case at the rate of 1 cwt. per 15 seconds, that is, 5 seconds for propelling the poise, 5 seconds for putting the strain on the specimen, and 5 seconds for taking the deflection reading.

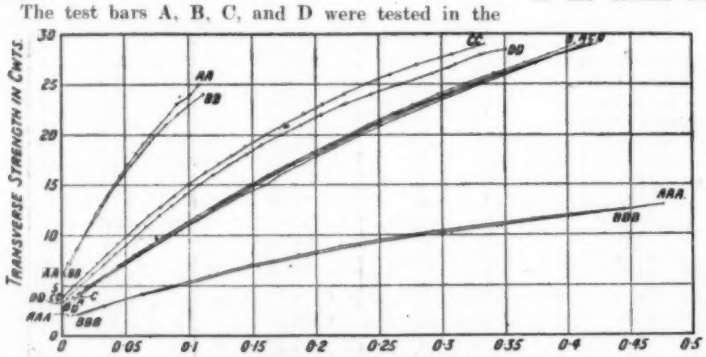


FIG. 1.—TRANSVERSE STRENGTH AND DEFLECTION OF CAST-IRON TEST BARS.

Two of the broken halves of the two bars A and B were machined down to 1-in. by 1-in. in section, and the two bars thus obtained were tested on 12-in. centres, and were marked AA and BB respectively. The other halves of the bars A and B were machined to 1-in. by 1-in. in section and tested on 24-in. centres. The bars are marked AAA and BBB. Two of the broken halves of the two bars C and D were machined to 1.5-in. by 1-in. in section and tested on 24-in. centres, and these bars were marked CC and DD.

Drillings were taken from each of the bars after test, a hole being drilled right through the bar, and it was found that all were of the same approximate composition.

The actual figures obtained from these tests are given in the Tables Nos. I., II., III., and IV., and are also plotted as a curve in Fig. 1.

It will be observed that the bars A, B, C, and D give the most consistent and comparable results both in breaking strain and deflection. The bars AA and BB, and also the bars AAA and BBB, give widely different results with regard to the deflection, the bars CC and DD also showing the same fault.

Actual Relation between the Two English Standard Test-Bars.—A number of test-bars were cast from mixtures of very weak to strong cast iron, 2½ in. by 1½-in. section 42 in. long, in the same way as previously described; they were then machined to 2-in. by 1-in. in section and tested on 36-in. centres. The results are given in the first column of Table V. It will be noted there is a good range of strengths. One of the broken halves of each of the broken test-bars was machined to 1-in. by 1-in. in section and tested on 12-in. centres, the result of which is given in the second column of Table V. The ratio of the 2-in. by 1-in bar tested on 36-in. centres to the 1-in. by 1-in. bar tested on 12-in. centres is given in the fourth column, which, it will be noticed, only varies from 1.142 to 1.166 in the whole series, as against 1.333 mentioned in the introduction to this Paper.

To ascertain whether the skin on the test-bar influenced this ratio, another series of test-bars of various strengths, but to standard sizes, was cast. In each test, two bars, 2-in. by 1-in. section, to be tested on 36-in. centres, and two bars, 1-in. by 1-in. section, were cast from the same ladle in immediate succession. After being fettled in the ordinary manner they were tested, the results being tabulated in Table VI.

Conclusions.

The best standard cast-iron test-bar to give the most consistent and comparable results both in breaking load and deflection is 2½-in. by 1½-in. in section, 42-in. long, machined down to 2-in. by 1-in. in section, and tested on 36-in. centres. The rate of testing should not exceed a load of 1 cwt. in less

than 15 seconds (15 seconds being a very convenient rate).

Instead of, as hitherto thought, the ratio of the 2-in. by 1-in. bar, tested on 36-in. centres, to the 1-in. by 1-in. bar, tested on 12-in. centres, being 1.333 times the breaking load, the experiments recorded in Table V on machined bars show the mean ratio to be 1.153; whilst in the bars tested with the skin on (see Table VI.), the mean ratio is 1.146 times the breaking load.

TABLE VI.—*Actual Relation between Cast-iron Test Bars 2 in. by 1 in. in Section on 36-in. Centres, and Test Bars 1 in. by 1 in. in Section Tested on 12-in. Centres.*

Cast Iron Test-Bars cast to size 2-inch by 1-inch Bar, and 1-inch by 1-inch Bar cast out of same ladle in different boxes in each case.

Breaking Load in Cwts.		Difference in Cwts.	Ratio of 2-inch by 1-inch Bar tested on 36-inch Centres to 1-inch by 1-inch Bar tested on 12-inch Centres.
2-inch by 1-inch Bars tested on 36-inch Centres.	1-inch by 1-inch Bars tested on 12-inch Centres.		
22·75	19·5	3·25	1·166
23·25	20·5	2·75	1·134
24·75	21·5	3·25	1·151
25·25	21·75	3·5	1·160
26·75	23·00	3·75	1·163
28·00	24·50	3·5	1·142
28·50	25·50	3·0	1·117
29·50	26·00	3·5	1·134
31·00	27·25	3·75	1·137
32·00	28·0	4·0	1·142
33·00	28·75	4·25	1·147
33·25	28·75	4·5	1·156
34·00	29·5	4·5	1·152
35·25	30·5	4·75	1·155
36·75	32·0	4·75	1·148

Mean ratio of 2-inch by 1-inch Bar tested on 36-inch Centres to 1-inch by 1-inch Bar tested on 12-inch Centres, equal 1·146 times the breaking load.

Standard Test Bars of Zinc-Bronze.

In a Paper presented at the annual meeting of the American Institute of Metals, at Chicago, Mr. C. P. Karr discussed experiments on the methods of making and the properties of standard test bars, undertaken by the Bureau of Standards at the suggestion of the Advisory Committee of the American Institute of Metals. The bronze dealt with was of the composition Zn. 2, Sn. 10, Cu. 88.

The object sought in this investigation of casting methods and properties of this bronze was to discover, first, the most suitable temperature at which the alloy could be poured to secure uniform and high results in tensile strength and ductility; second, to ascertain the most desirable methods of moulding; third, to obtain a method of gating so as to avoid undue shrinkage in the castings and the production of internal stresses during solidification; fourth, to ascertain what shape of casting, if any, could be depended upon to secure the best results; fifth, to compare the results obtained in sand versus chill castings; and sixth, the effect of heat treatment on the properties.

The methods of pouring may be summarised as follows:—The series was poured vertically in dry sand; the patterns used were the cylindrical, the barrel, and the cast-to-size shapes. With every heat a chill bar was cast, of a length sufficient to make three test bars. As a rule the chill bar was poured about the middle of each heat or after the second flask of moulds had been poured. A moulded cavity was made in the mould so as to provide a reservoir of metal from which each shape could draw a supply of molten metal sufficient to compensate for the amount of metal absorbed from the gate during solidification.

The form of chill bar employed was not strictly a chill bar, because the bar was set as level as it could be placed, poured from one end, but left open to the air on the long upper side; this meant that the bar on cooling received the chill on three adjacent sides only, and not on all four sides as would have been the case had the mould been strictly of the chill-mould type.

The results of the experiments are summarised as follows:—

The best type of test bar where the metal is to be cast in sand, to secure uniformity of physical properties, independent of the temperature at which it is poured, is the cast-to-size shape.

The best temperature for pouring a specimen is indeterminate, but the zone most favourable to good results, all other conditions being the same, lies between 1,120 deg. and 1,270 deg. C. In the results achieved in the first three series it appeared as if there must be one temperature, which, if ascertained, would prove to be the most desirable; but unexpectedly and fortunately the completed series demonstrated that the region of temperatures favourable to good results was quite extensive and was conducive to readily regulated practice in well organised foundries.

The method of moulding to be recommended is a dry-sand mould, poured either flat or vertical. The first method is more economical of time and labour, and yet has no superiority over the vertical pouring in technical results.

The merits of the chill and best sand-cast test bar are almost of equal value if the chill bar be annealed at a temperature ranging from 500 to 700 deg. C., but otherwise it is inferior to the sand cast-to-size shape for the best representative results. The advantages of the chill bar are no moulding requirements and that it can be poured by unskilled labour. Its disadvantages are that it is expensive to machine into shape and size required for testing, and it gives results both as to tensile strength and ductility that are misleading. The advantages of the cast-to-size shape are, that it is easy to mould, and inexpensive to machine into shape and size required for testing. From the results obtained this latter is believed to be the form which should be standardised for general foundry practice.

Heat treatment is productive of increased ductility, and in the temperature zone of 600 deg. to 700 deg. C. has a marked effect on the deformation produced by continuous increasing loads, which is in accord with the results of other observers.

As an alternative to the sand-cast specimen, if one prefers to work with a chill-cast specimen, as is the case in some foundries, the results show for the few observations taken that when annealed between a temperature range of 500 deg. to 700 deg. C. a normalised chill bar is secured which is comparable to the sand cast-to-size shape. The quenched specimens offer no appreciable superiority to the annealed specimens

General averages of all the observations taken are as follows:—

No. of bars.	Shape.	Tensile strength lbs. per square inch	Elongation in 2 inch per cent.	Reduction of area per cent.
217	Cast to size	37,869	15.5	14.7
161	Cylindrical	32,832	14.9	13.9
95	Barrel	32,029	14.2	13.8
88	Chill cast	36,512	6.3	6.9
21	Sand cast, annealed ..	38,190	27.0	26.0
16	Sand cast, quenched ..	39,810	26.9	24.2
5	Chill cast, annealed ..	31,160	17.0	16.7

Discussion on "Semi-Steel."

At a meeting of the Lancashire Branch of the British Foundrymen's Association on November 7, Mr. T. W. Markland (President) in the chair, a discussion was opened by Mr. S. Roe, who said he had for a long time been interested in "semi-steel" castings and had got into communication with Mr. McLain, of Milwaukee, U.S.A., upon the subject. In heavy castings he had been very successful, and also when the smaller castings were taken directly from the cupola into the mould. The difficulty arose when he carried the metal 30 or 40 yards before pouring. When it got to the milling machine there were hard spots at the riser end. At the runner end it was all right. What was the remedy? Mr. McLain said manganese, but as manganese was used for hardening castings he did not exactly see how it would enable him to get rid of the hard spots. Therefore, he solicited the opinions of the members on the subject. The castings in question were 50 in. long, 1 7-16 in. wide, ¼ in. to 3-16 in. thick, and the moulds were of green sand. The proportion of steel scrap used was 10 per cent. to start with, then reduced to 5 per cent.

Mr. T. Craig said he had used semi-steel mainly for heavy work, and had even run it down into pig. Fifty per cent. steel scrap mixed with "N. L. B." No. 3 iron yielded a white iron; 50 per cent. steel scrap with "Apedale" No. 4 yielded a grey iron very similar in fracture to a No. 5 or No. 6; and 50 per cent. steel scrap with hematite gave a grey iron. When hematite and steel were mixed together something was wanted to make it fluid, and that end was attained by putting in manganese. The 50 per cent. steel with "Apedale" was run down only for puddling. If he were making a cast-iron plate shear about a foot in diameter he would use a mixture 3 of steel, 3 of hematite, and 1 of "Apedale." That would run down somewhere about 1 per cent. silicon, 0.9 per cent. manganese, 0.8 per cent. sulphur, and 0.5 per cent. phosphorus. That was as strong an iron as one could get, judging from the analysis of it. It was practically a cold-blast iron, but, of course, there was a very big difference in price between a semi-steel mixture and a cold-blast iron. He had used 15 per cent. of semi-steel in a mixture cast into what was known as a mild chill roll—that was a roll cast in chills, but which would show no chill when the skin was broken. It was necessary to have a soft iron in a case of that description.

Mr. Roe remarked that he was also successful in jobs of the nature described; it was the small sections in which he failed to achieve satisfactory results. The castings were run perfectly and looked just like ordinary castings, but when they got to the milling machine, at the extreme end away from the runner there were little spots, pin-head spots, which were too hard. Annealing had been tried, but did not overcome the difficulty. As to the method by which the softening was done, there was an oven connected with the smithy, and the castings were placed in the oven and removed the next morning, but on being taken to the milling machine they were no better. It was necessary that the castings should spring, and when he had them softened they lost their springiness, so that his object was defeated.

Mr. D. Cordingley thought they would not lose their springiness if the exact time to be given to the operation were ascertained by a series of experiments and carefully regulated.

Mr. A. L. Key inquired whether it was necessary to use semi-steel for the castings in question. Was there any particular advantage obtained from it?

Mr. Roe replied that it was a matter of economy. There was a considerable saving effected by using the steel scrap instead of selling it.

Mr. Key said he did not think satisfactory results were arrived at from trying to make castings of so thin a section in green sand, with that percentage of steel scrap; there was certainly no economy if the process was going to produce a lot of wasters. He would suggest that instead of using hematite Mr. Roe should get a pig with a silicon content of 3 to 3.5 per cent and use about 5 per cent. steel; but even then he could not rely on getting what he wanted when it was annealed. Even in dry-sand work there were considerable variations. He once made an experiment using 50 per cent. of steel and 50 per cent. of pig containing 3.6 silicon, 0.7 manganese, and about 1.8 phosphorus. He got a beautiful blue grey fracture with that. When he came to use a No. 3 iron with the same pig the fracture varied from mottled grey to mottled white. If Mr. Roe would try that he would probably get nearer to his goal than he had yet been. There was no doubt about it that in order to work successfully it was necessary to have a high manganese content; manganese was the foundation of the whole process. Used in a grey-iron mixture it was a hardener, but when working with steel it had a softening effect.

Mr. J. Whittam asked whether Mr. Roe had tried a dry-sand mould. He was inclined to think a perfect casting would not be got unless the mould was dried.

Mr. Roe: I have not, because these things are to be produced in thousands per week. They are made piecework, and anything of that kind would simply kill the job. The castings have to stand 700 lbs. on 3-ft. centres. The bars are tested and give up to 3,300 lbs. The deflection is about 3/16 in.

Mr. Craig asked what was the weight of the charge of semi-steel. In his own work, when charging two tons of semi-steel he divided it into four charges of 10 cwts. He found that if he took a hand ladle out of the first 30 cwts. and another hand ladle out of the last 10 cwts. the latter was much harder than the former. The reason, he supposed, was that the steel gathered. It did not matter how the charges were divided. They might even follow on with a charge containing no steel and still the last lot when withdrawn was harder than the first.

Mr. Roe said the cupola he was speaking of had in front a receiver capable of taking 6 tons. He had been working with 30-cwt. charges and he never tapped it until he had about four or five tons in the receiver, so he should imagine it was pretty well mixed up by that time. He could make a casting successfully in front of the cupola, but when he took the metal a distance of 30 or 40 yards there seemed to be a change and the hard spots came out at the end of the casting.

Mr. A. Sutcliffe: Would not a runner at each end and a blow-off in the middle get over the difficulty?

Mr. Roe replied that such a method would add to the cost of production. The questions of speed and piecework had to be taken into account.

Mr. Key said hematite did not always give what was promised, and he would recommend Mr. Roe to try instead a high phosphoric pig. If a very soft iron were mixed with the steel, Mr. Roe would be able to carry the iron much further than he did now,

because at present he had to contend with one of the worst elements as regards retaining heat or maintaining fluidity for any length of time. Steel was about the worst thing they could put into iron to take the life out of it. He also observed that a tremendous amount of coke was used. His experience was that the more coke used the less the length of life there was in the iron. For some time past the furnace at his works had not been melting as fast as previously, and he noticed that the iron lost its life sooner. It was filled with regulation skips and he found that new skips which had been applied, though supposed to be exactly as the old ones, contained 40 lbs. as against 30 lbs. Consequently while the men put into the furnace the same number of skips they were really increasing the amount of coke by 33 per cent., and the effect of that was to be seen in the different behaviour of the metal. He altered the method of measuring the coke and got the metal back to the usual condition. If putting extra coke was going to give an extra hot iron (as undoubtedly it did) it must take the life from the iron. Therefore it was quite possible that Mr. Roe might be using too much coke. He had made castings of steel and sometimes he had a difficulty in getting rid of the metal when it was in the ladle. At other times it ran like water.

Mr. Roe, in reply to questions, said he used Bessemer mild steel. He had tried a high-carbon steel, the percentage of carbon being about 0.5; but there again the question of price arose.

Mr. Cordingley said he had had practical experience of excessive coke producing spongy castings. With a normal amount of coke one would get something like an equal surface in machining. If the amount of coke were too low, then it would simply result in the metal not being melted. If too much coke were used, there must be some effect produced on the different constituents of the iron; if they were burnt out and passed into slag it must effect the product. Perhaps that would account for the hard spots.

Mr. Harrison remarked that the result of adding the steel was that the proportion of silicon in the mixture was lowered; in effect it was diluting the iron. It had been proved that the steel melted before the pig.

Mr. Craig thought the best way to produce the semi-steel casting was by the air furnace, and he did not see there would be much difficulty in doing so. The cost of fuel was probably less, and he did not think it would cost as much to keep in repair. Some people said that the air furnace cost more, but that was not his opinion. One point in its favour was that heavy scrap could be put in. Practically any pig could be converted into a cold-blast iron in the air furnace. The air furnace took a little more out of the iron than the cupola did. Suppose, for example, six tons were put in, they would get out about 5 tons 10 cwt.; the amount of silicon and manganese were lowered more than would be the case in the cupola. But, of course, knowing what was going to happen they would put in what was required to make up for the loss.

Mr. Jarvis said it seemed to him the hard spots were due to unequal diffusion or segregation, resulting from inequality of temperature.

Mr. Key thought the trouble was caused by low temperature. The steel was diffused through the iron and while the mixture was sufficiently hot to remain fluid it was all right but if it came into contact with anything that chilled it, the particles of steel chilled and set immediately.

Mr. Craig remarked that this seemed to be contradicted by his own experience of a mixture containing 15 per cent. of steel. The casting was 5 in. thick and once the skin was broken there was no chill.

Mr. Key said the two cases were not comparable. A casting of that thickness retained an amount of heat sufficient to impart fluidity to the steel, but when the casting was only as thick as a pencil it could not resist the chilling effect.

Mr. Roe pointed out that the spots were only the size of a pin-head and about $\frac{1}{2}$ in. to $\frac{3}{4}$ in. apart. Between the spots the metal was all right.

Mr. Key said the steel was not of the same composition as the iron and did not melt at the same temperature. It had to change its nature by absorbing carbon in the furnace before it could melt. It was a different texture to the iron.

The discussion was closed without any further agreement on the matter.

The Air Furnace and the Cupola.

Mr. Craig said he would like to hear the views of the members on the point of whether it was wise to allow the air furnace to fall into disuse.

Mr. Andrew said he thought the air furnace would be a good thing as far as semi-steel was concerned. One objection to it was on the ground of expense, but if it could be used as constantly as the cupola that objection would be got rid of to a great extent.

Mr. Key said the reason why the air furnace had fallen into disuse, but not into disparagement, was commercial competition—the desire to produce something cheaper than it had produced before. A man who had been using an air furnace to get a particular quality of iron thought he could get the same quality out of the cupola at a lower cost. Or possibly he heard that someone else was producing a similar quality of iron from a cupola and he came to the conclusion that he must do the same himself and reduce his cost, provided his customers were willing to take the product. There were still some buyers who specified air-furnace metal, but there were not as many as there used to be, because the prices for castings produced in that way were considerably above the standard of prices for castings from the ordinary cupola.

Mr. Craig suggested that heavy scrap might be used in the air furnace without the previous necessity for breaking it up. There was an advantage in that respect. Again, high prices were being paid for cold-blast iron and they would not need so much cold-blast iron if the air furnace were used. He was only suggesting the use of air furnaces for certain jobs; there were many cases where it would pay well to put in an air furnace.

RECONSTRUCTION OF SOUTHWARK BRIDGE.—As is well known to London readers, the Southwark Bridge over the Thames has for some eighteen months been undergoing a process of demolition, with a view to reconstruction. The old bridge, designed by Sir John Rennie, was completed in 1819. The cast iron employed in its construction was cold-blast of excellent quality. The old bridge was, from an engineering point of view, a noteworthy example of the application of cast iron to bridge building. According to Robert Stephenson, as an example of arch construction, it stands unrivalled as regards its colossal proportions, its architectural effect, and the general simplicity and massive character of its details. In November, 1909, the Corporation of the City of London decided to reconstruct the Southwark Bridge, and the process is now in progress. We understand that the cold-blast iron of the old bridge has been bought by Messrs. Thomas W. Ward, Limited, Thames Road, Silvertown, E.

The Rapid Analysis of Aluminium Alloys.

By F. H. Hurren.

The chief constituents of aluminium alloys are aluminium, copper and zinc, with traces of iron and silicon. In addition there are usually very minute traces of sodium, carbon and nitrogen. These last-mentioned are very rarely determined in ordinary works practice, although, in the writer's opinion, nitrogen has a very marked effect on the tensile strength of aluminium alloys. It is a well-known fact that aluminium which has been overheated, or allowed to remain in the furnace long after being melted, shows a considerable diminution in tensile strength; and is technically described as "burnt." This is probably due not so much to oxidation as to the absorption of nitrogen, with the formation of aluminium nitride. In support of this, the writer has cast test bars in alloy properly melted, replaced the crucible in the furnace, purposely overheated the metal, and cast further test bars. The first metal gave an average tensile strength of 11.8 tons per sq. in., whilst the "burnt" metal gave an average of 4.3 tons per sq. in. On analysis the former was found to contain 0.003 per cent. nitrogen, against 0.41 per cent. nitrogen in the "burnt" metal. Further experiments on the same lines gave similar results. These figures clearly show the necessity for care in melting.

For most works purposes a determination of copper and zinc only is necessary, with an occasional determination of iron. The methods given below have been in use daily for some time past, and give results sufficiently accurate for foundry purposes.

Determination of Copper.

The following solutions are necessary:—

Standard solution of sodium thiosulphate.—Weigh out 39.5 grammes of pure thio. crystals into a graduated litre flask. Dissolve in about 200 cc. distilled water, then make up to the mark with distilled water and mix well. Each 1 cc. of this solution should equal 0.01 grammes of copper. To standardise, weigh out accurately 1 gramme pure electrolytic copper foil, add 20 cc. dilute nitric acid, boil down to about 5 cc., dilute with a few cc. distilled water, add 10 cc. dilute sulphuric acid, transfer to a 100 cc. graduated flask, and make up to the mark with distilled water. Fill a 50-cc. burette with the thio. solution to be standardised. By means of a pipette, withdraw 25 cc. of the copper solution, transfer to a 350-cc. conical flask, and add about 2 to 3 grammes of potassium iodide crystals. The solution will become a deep brown colour. Run in the thio. solution from the burette a few cc. at a time, shaking the flask after each addition, until the brown colour fades to a straw yellow. Then add 2 cc. freshly-made starch solution, when a deep blue coloration is formed. Continue the addition of the thio. solution, drop by drop, until the blue colour completely disappears, and does not reappear in two minutes. Read off the volume of thio. used. If the solution is accurate, 25 cc. should have been required. If weaker or stronger, more or less than 25 cc. would be used. If the solution is too strong the exact amount of water necessary for dilution should be calculated and added. It is as well, then, to check the solution against a further 25 cc. of standard copper solution. If the solution is on the weak side, place it in a clean, dry bottle, and label it with the necessary factor.

For the actual determination of copper, weigh into a 300 cc. beaker, 2 grammes of drillings, and add 50 cc. of a 20-per cent. solution of sodium hydrate. Heat just to boiling, and when effervescence ceases, dilute to about 90 cc. with water. Allow the black residue to settle, and pour off the clear liquid. Again dilute with about 40 cc. hot water, boil, allow residue to settle, decant the clear liquid, and finally filter the remainder through an 11-c.m. paper, and wash twice with hot water. Mix the washings and decantations, and set aside for zinc determination (see later). Dissolve the black residue in 15 cc. dilute nitric acid, boil until all red fumes are evolved, neutralise with ammonia, then add 10 cc. concentrated acetic acid, and boil. Cool, add about 2 grammes potassium iodide crystals, 2 cc. starch solution, and titrate with standard sodium thio-sulphate until the blue colour just disappears, and does not reappear in two minutes.

If X cc. thio. are required,

$$\frac{100 \text{ X} \times 0.01}{2} = \% \text{ copper.}$$

Determination of Zinc.

Transfer the decantations and washings obtained in the copper determination, as above, to a 500-cc. graduated flask, and make exactly to the mark with water. Measure off 250 cc. (equal to 1 gramme) into a 500-cc. beaker, boil, and add 10 cc. of a saturated solution of sodium sulphide, or pass a brisk current of hydrogen sulphide through the solution for five minutes. Allow precipitate to settle, and filter through a fairly close-grained paper. Wash precipitate once with water, then dissolve in 20 cc. hot dilute hydrochloric acid, into the original beaker. Boil for five minutes, float a piece of litmus paper on the solution, and make just alkaline with ammonia. Now add concentrated hydrochloric acid from a graduated measure, drop by drop, until just neutral, and then 5 cc. excess. Heat to nearly boiling. Titrate with standard potassium-ferrocyanide solution. Run this solution in a few drops at a time, until a spot withdrawn on a glass rod and placed in contact with a spot of uranium acetate solution on a porcelain tile, just shows a brown coloration.

The standard potassium ferrocyanide solution is made by dissolving 41.25 grammes pure crystals in water, and making up exactly to a litre. Each cc. of such solution equals 0.01 gramme zinc, or one per cent. zinc on one gramme of alloy.

Determination of Iron.

Weigh into a 350-cc. conical flask 0.5 gramme drillings, and add continuously 10 cc. concentrated hydrochloric acid. Boil, dilute to about 20 cc. with water, float a piece of litmus paper in the solution, and just neutralise with ammonia. Add 15 cc. concentrated sulphurous acid, fit the flask with a cork, and Bunsen valve, and boil for 5 minutes. Cool quickly under the tap, add 10 cc. dilute sulphuric acid (S.G. = 1.2), and titrate quickly with standard potassium bichromate until a spot of solution withdrawn on a glass rod and placed in contact with a spot of dilute potassium ferrocyanide solution, on a porcelain tile, just fails to give a blue coloration.

The standard potassium bichromate is made by dissolving exactly 0.877 gramme crystals in distilled

water, and making up exactly to one litre. Each cc. of this solution equals 0.001 gramme of iron, or 0.2 per cent. on half a gramme of the alloy.

These three determinations are all that is usually done on aluminium alloys, and having all standard solutions made up, an expert operator may, by using these methods, do a complete analysis in thirty-five minutes from the time of the first weighing out.

Determination of Nitrogen.

In conclusion, the writer will give the method for determining nitrogen. This is practically Kjeldahl's method, with modifications. Fit up a 500-cc. conical flask with rubber stopper, bored with two holes. Through one of the holes insert a thistle funnel with the end within an inch of the bottom of the flask, and through the other hole a delivery tube, bent twice at right angles, with one end about an inch through the cork. Weigh out exactly 0.5 gramme of drillings into the flask, insert stopper and tubes, and clamp the flask to a retort stand. Add 30 cc. dilute sulphuric acid (S.G. 1 2) through the thistle funnel, and heat gently until solution is complete. Now place the open end of the delivery tube in a flask containing 25 cc. decinormal sulphuric acid, so that the end of delivery tube is well below the surface of the acid. The flask containing the decinormal acid must be immersed to the neck in a basin of cold water. To the aluminium solution, add, through the thistle funnel, 50 cc. of a 30-per cent. solution of sodium hydrate. Boil briskly for 20 minutes, allowing the steam and gases evolved to pass through the decinormal acid. Then disconnect the delivery tube, wash with cold water, the washings being run into the flask containing the decinormal acid. To this flask add two drops methyl orange, and run in from a burette decinormal sodium hydrate solution until the pink colour just changes to yellow. Read off the volume of alkali used, and this deducted from 25 cc. gives the volume of decinormal acid used in the determination. Each cc. decinormal acid used is equivalent to 0.0014 grammes nitrogen, or 0.28 per cent. on half a gramme of the alloy.

War Scrap Iron Castings and Yellow Metal Scrap.

By Walter J. May.

Before very long there is no doubt that a large quantity of cast scrap iron and steel will be brought to this country. In dealing with war scrap there is as a rule, a fair bulk of unbroken shells as well as broken stuff of various kinds, and with the unbroken shells considerable care has to be taken, as there is always a risk of having one or more fully charged. Needless to say, a charged shell is a very dangerous thing to get into a cupola, because in the event of even a 3 in. or 75 mm. shell exploding, in all probability the cupola would be wrecked and other damage done, while the workmen would probably receive more or less injury. For this reason all unbroken shells need special examination, and all those holding anything inside them, or which still are plugged at the charging end must be laid on one side, either to be dealt with by someone who understands shells, or to be taken away by someone connected with the War Office. A communication to the latter will bring an inspector down pretty quickly where explosive war material is concerned—at least that has been the writer's experience. The safest course, however, is to insist that only broken shells be sent by the iron merchant, as this places on him the responsibility of dealing with probably dangerous goods.

It is not usual for copper, or copper alloy parts to be sent out from the merchant's yard, owing to their value, but at times such metals do come out, and in one case the writer got nearly 3 cwts. of bronze fittings from a lot of piping coming from a chemical works, and it is interesting to note that 10s. per ton was allowed off the price of the scrap iron on account of its being very dirty. In dealing with war scrap, however, much of the metal is dirty, and it is quite possible for a fair amount of copper or brass to be missed in the collection and quick over-haul given by the merchants, for which reason the sorting of the metal at the foundry should be done with the view of taking out all foreign metals from the iron. Do not attempt to take metal plugs out of unbroken shells; it is too risky unless the work is done by skilled men used to the class of projectile dealt with. This matter must be rather carefully kept in mind.

Of course, somewhat careful sorting of the metal will have to be done to get different grades, for while most of the iron and steel used is good, there are variations in both quality and hardness, a small Maxim shell being of different quality to a 14-pounder. Some of the shells also, are made from scrap metal, which again causes a difference in quality, and this has to be considered, but generally a good sorter can turn out very regular piles of graded metal for most purposes.

For work which has not to be made to any particular specification, old scrap from the battlefield forms a fairly cheap and handy form of metal, and probably will form a large part of the iron used in many places in the near future, as the supply will be extremely large. Probably some kind of flux will be necessary in the furnace when melting, to secure the better amalgamation of the different irons, but will only be determinable where the scrap is being dealt with.

Other scrap, such as cartridge shells, rings and plugs from heavy gun shells, bullets with their nickel cases loaded with lead, and similar waste will be collected, and eventually find their way into the hands of melters and foundrymen, and as they are all good metal according to their kind they usually are worth buying. Some care is necessary to see that live cartridges are not present amongst the smaller stuff, and as a rule cartridge cases should be melted by themselves after careful sorting and examination. Detonations sometimes occur where cartridges have not exploded, and such things should be viewed with suspicion, although they are not always dangerous.

In sorting this form of scrap, brass, gunmetal and copper, nickel and lead will be found, and as each is of good quality the metals usually can be used right away, but generally it is desirable that they should first be run into ingots to maintain regularity of content. Of course, the bullets will be heated to separate the lead from the nickel, the molten lead being at once run into ingots while the nickel shells, after being well roused about to shake out the molten lead, will have to be melted down in crucibles. In this sort of work large crucibles of at least 4 cwts. capacity should be used, and for this purpose tilting furnaces will be found very convenient.

Most of the soft scrap metal requires the use of some deoxidant flux when melting for making into ingots, but after being once cleaned they should be no further difficulty in regard to occluded oxides and dirt, the actual casting work being practically the same as with new metal.

Foundry Troubles ; Analysed and Synthesised.*

By T. W. Aitken.

Foundry troubles may be grouped into three classes : —

(1) Attributable to the forces of gases and steam.

(2) Caused by the force of contractions.

(3) Arising out of the different properties of the various constituents of the mixture.

Amongst those troubles which come under Group 1 are blow-holes and scabs. These two are closely allied, as they are both (in the case of grey cast iron and brass) the result of the presence of steam or gas which has overcome the pressure of the molten metal whilst being poured into the mould. It becomes necessary, then, to locate the source of such steam or gas and to reduce the quantity to a controllable amount, or to made adequate exits for the steam or gas to freely escape, or in some cases to increase the pressure of the gates.

In dealing with the source of steam it becomes necessary not only to work the sand as dry as possible, but to see that chaplets or screws, if such are used, are free from rust; for since these when placed in the mould are almost enveloped in metal, it is not possible to make sufficient provision for the escape of the steam which would be caused by the using of a rusty chaplet or screw. Iron rust is a chemical combination of oxide of iron with water, which is decomposed by the heat of the molten metal, releasing the water and gases.

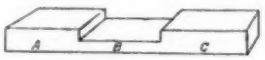
A scab on a green-sand mould is the result of gas or steam not having free escape from the mould in the drag side, owing to the mould being rammed too hard and insufficiently vented, or the sand too damp. The sand may not be too damp in the aggregate, but it may have wet spots. When it is considered that water on conversion to steam increases in volume to the extent of about 1,700 times its original volume, the importance of making ample provision for its rapid escape and the use of as little water as possible in green-sand moulds can be more clearly seen. It is much safer to reduce the quantity of water in the sand and add a binder, as gases which may be formed by the fusion of the binder are not so difficult to control as is steam. The writer has made several experiments in this direction with good results.

In dealing with gases in a mould, we should give thought to Charles's law, which states that "The volume of a given mass of gas, kept at a constant pressure, increases by a definite fraction of its amount at 0 deg. for each degree rise in temperature." This fraction is called the co-efficient of expansion, which is about $\frac{1}{273}$. From this we could gather that a certain quantity of gas heated to 1,000 deg. Centigrade would only expand to an increase of about four times its volume at 0 deg. Centigrade.

The troubles which come under Group 2 include warped castings and cracked castings, these defects being both due to uneven contractions induced by different thicknesses of metal in the same casting, and in some cases due to the heat of the runner which is attached. The total contraction under normal conditions is fairly constant for a given grade of metal, so that allowance for sizes can be easily made for contraction whilst making the pattern; if this result is not obtained then one may confidently look for blow-holes or some such defects.

Considerable light is thrown on the question of the effects of uneven cooling by the result of certain of Prof. T. Turner's experiments, according to which white-iron shows a pasty stage and then contracts regularly till about 665 deg. Cent. is reached, when there is a slight retardation. Non-phosphoric grey-iron shows two marked expansions, one immediately after the metal has become sufficiently solid to move the points of the measuring instrument used, and at a temperature of about 1,140 deg. C., the second at 695 deg. C. Phosphoric grey iron (1.25 per cent. P.) has three actual expansions, one from the moment of solidification, but reaching its maximum at 1,060 deg. C., the second about 900 deg. C. and the third very marked and long continued at 730 deg. C. The lowest changes are considered to be due to the formation of amorphous free carbon, produced by the decomposition of the carbide of iron (Fe_3 C.).

A casting which is uniform in section will have one centre to which the whole will contract—that is providing the runner is not heavy enough to effect the



regular cooling down of the casting; but a casting of irregular section, as in Fig. 1, will have three separate centres of contraction. The light part B will cool more quickly than the heavy parts A and C, and by so doing the complete casting will behave as though it consisted of three distinct parts. The contraction of the part A will be directed towards its own centre, and the other parts B and C likewise will have their contractions directed to their own separate centres. Therefore, in each of the three portions of the casting the metal will be drawing away from the junction of the adjoining parts; this may be sufficient to develop a fracture along the junctions, but even if this effect is not produced a serious plane of weakness must occur, so much so that if a casting which is required for containing steam or air is so constructed, it would reveal porosity at those junctions. These facts are almost sufficient to condemn such sections as impractical, were not a remedy available in hastening the cooling of the heavier parts so that each separate thickness is aided to cool down at about the same time, bringing the separate centres of contraction closer together. If the rate of cooling were equal throughout the whole casting, the three centres of contraction mentioned would merge into one.

Whilst considering the effects of contractions on castings with varying sections, the fact must not be overlooked that metals are good conductors of heat; in applying any method, such as chilling, to hasten the cooling of the heavier parts, this property of heat conduction will always be of assistance.

If this theory of the drawing-away of the metal of a casting to several different centres be applied to a large casting, it will be seen that one portion of such a casting will have completed its contraction some time before the other parts, with the result that the lighter portion will have become cold and rigid and therefore

*Read before the London Branch of the British Foundrymen's Association, November 20, 1914, Mr J. Ellis in the Chair.

unyielding to the forces of contraction of the other parts, so much so as to cause the lighter parts to bend or twist and so form a warped casting. To obviate this trouble it becomes advisable in some cases to make the pattern out of truth, so that the pull of the heavier part will have the effect of straightening the lighter part.

As the use of chills is general, in hastening the cooling of a casting or a part of same, it will not be out of place at this stage to give a little consideration to the action of a chill. Experience has shown that a chill to be effective must be made of metal, and the metal usually chosen is iron, owing to it being a good conductor of heat, cheap and adaptable. Of all metals the best conductors of heat are silver and copper, but as too much of each of these is required to meet the necessary expenses of a foundry, we will not make any further claim on their utility.

When the metal comes into contact with the chill used on a face of a mould, the chill immediately commences to convey through its own mass heat from the surface which is in contact with the hot metal and continues to do so until the chill and the casting become of equal temperature. From this it will be clearly seen that the larger the chill the more heat will be taken from the casting to bring them both to the same temperature, and, further, if a chill has only a small surface in contact with the casting and yet has a large area in itself, the heat which is conducted from the casting will be taken away very rapidly at the surface of contact. Hence a deeper chill is shown, or the closing up of the grain at this part extends deeply into the casting. Chills may therefore be considered as heat conductors. A simple and interesting experiment which can be made to illustrate the different conductivities of different metals and materials is as follows :—Round a cylinder one-half of which is brass and the other half wood (or one end of a wooden cylinder can be turned down so that a brass tube of the same diameter can be slipped over it), is tightly wrapped a piece of writing paper, so that half of the paper covers brass and the other half wood. This is then placed over a flame, when it will be noticed that the paper which is covering the wood will be scorched whilst that over the brass will remain almost white for some time; a definite line will be quite noticeable, demonstrating that the brass has conducted away the heat sufficiently quickly to keep the paper below the temperature at which it will burn, whilst the wood has not had this effect, allowing all the heat to remain in the paper.

A heavy casting will show less total contraction than a light one made of the same metal, yet when dealing with one casting which has both heavy and light parts, one is led to believe that the reverse is the case. Take, for instance, a plate, say, 24 inches square, the pattern of which is perfectly flat on the one side but thicker at the edges than in the centre. if the runners to cast this are placed by the edges, the result will be (if no part is aided in its cooling by stripping or any other method) the casting will come out with the centre bellied or bulged, or the edges will open up, thus indicating that the heavy part has contracted more than the light part.

The explanation of this is that the lighter part cools first and so contracts sooner than the heavy part, but at the temperature at which the first contraction takes place (supposing this casting to be made of grey iron), the metal is in a condition to yield to a tension without revealing any weakness, and so stretches out to remain the same length as the heavy part; and when the light part cools down to the temperature at which the second contraction takes place, the heavy part is also contracting for the first time (the whole casting, if examined at this stage, will be found to be perfectly level and showing no warping). The light part may now be considered to have completed all contraction, but the heavy part has still one contraction to make and in so doing buckles up the light part if that part is thin enough to yield, or, if not, then the heavy part will crack and complete its contraction to two centres.

The chief of the troubles which come under Group 3 are segregations and porosity. It is well known by foundrymen that cast iron is a mixture of iron with other metals and non-metals, but many who talked freely about these elements are not aware of the form in which they exist in cast iron and how they behave.

The carbon, silicon, manganese, phosphorus and sulphur (these being the chief impurities in iron) do not exist as free elements but in a state of combination one with another, forming compounds. These compounds have properties entirely different from their separate elements and the physical properties of the cast iron depend upon the completeness with which these substances mix with each other and remain so until the casting has reached that temperature when no further changes can take place, and not upon the individual percentages of the elements in the mixture. If these substances were all completely soluble and no separation occurred, then segregation would not be classed as a "foundry trouble." Such, however, is not the case, as some of these substances only remain in solution whilst the mixture is at a high temperature; after the temperature has become reduced they separate out, the total amount of such separation being governed by the time taken in cooling. Quenching and rapid cooling arrest this separation.

These separations must be considered as being in two distinct forms :—(1) those which separate from the solution and become solid before the bulk of the metal and (2) those which are left liquid as the bulk of the metal solidifies. Carbon comes under the former and the compounds of phosphorus under the latter. When cast iron is in a perfectly molten condition, all the carbon present is in solution (and would remain so if the temperature of the metal could be maintained), but in cooling the graphite separates out and being a light substance floats to the top of the molten mass, this continuing as long as the metal is fluid. After solidification has commenced the remaining carbon separates in the form of particles distributed throughout the iron; the size of these particles depends on the rate of cooling, or in other words, upon the length of time free motion is given to them.

Certain compounds of silicon promote the decomposition of the carbide and lower the saturation limit, thus promoting the formation of graphite. This produces open-grained castings (if of a fair thickness) if not arrested by quenching or rapid cooling. Therefore, to obtain close-grained non-porous castings the silicon content must be low.

Phosphide of iron is the most fusible constituent of phosphoric cast iron and consequently lowers the melting point of the metal containing it. As the temperature of the metal falls the excess of phosphide forms, with the other fluid portions of the metal, a liquid which has a very low melting point; this liquid will continue to deposit some of the constituents with a higher melting point, so that the remaining liquid will become high in phosphorus and remain molten until the final solidification. Consequently it will occupy middle areas in the course of solidification of the casting and finally on complete solidification be in the form of a meshed network, known by foundrymen as segregations.

With non-phosphoric cast iron, segregations occur especially if the section of the casting is favourable to slow cooling; but these segregations are not so pronounced and difficult to overcome as in the case of metal high in phosphorus. Cast iron being an alloy composed of several constituents which have various freezing points, we must have one or more of these constituents remaining in a liquid state after others have become solidified; therefore, if the casting is a heavy mass and so cools slowly, we shall have this most fluid constituent concentrated in one part of the casting, naturally about the centre of same, as the casting will cool from its outside surface.

In the foregoing the writer has attempted to deal with the fundamental difficulties that arise with general foundry practice; but that there are numerous other minor troubles which occur all too frequently, most of which are closely associated with those here considered.

The lecture was illustrated by a variety of castings showing the troubles in question.

Discussion.

The CHAIRMAN (Mr. J. Ellis) in opening the discussion, said that the lecturer's contention of the casting in Fig. 1 contracting to three centres would involve the ultimate size being greater than it was actually found to be in practice, as the contraction movements in portions A and C would be away from instead of towards the centre of B.

MR. LAMBERT remarked that the lecturer had referred to silicon, carbon, phosphorus, sulphur, etc., as impurities in iron, whereas they were really essential constituents of cast iron.

MR. T. R. ROLFE, referring to the question of rusty chaplets, said that water was not necessarily present in oxide of iron. It was, of course, possible that a rusty chaplet's rough surface would have more moisture condensed upon it from the atmosphere. His own suggestion as to the cause of the blowing trouble associated with rusty chaplets was that the oxygen in the oxide attacked the carbon in the molten metal, and thus formed a gas (CO or CO_2), which produced the defect in question. This contention was supported by the fact that mild-steel chaplets with a skin, probably a sub-oxide produced in the rolling process, gave similar trouble with gas holes. An examination of the metal in the immediate region of the chaplet showed some reduction of carbon, which further pointed to the partial removal of that element by combination with oxygen.

MR. W. A. NAISH remarked that beside the contraction of a casting the effect of cooling on the hardness had to be considered. Did Mr. Aitken consider chills (denseners) as the sole panacea for the troubles of irregular cooling?

The SECRETARY remarked that Mr. Aitken had not laid enough stress on the difference in final total contraction of thin and thick sections. It was a well-known fact that heavy castings contracted less than light ones, the reason for which would be apparent on examining the cooling curves of the same iron cast in two different sections and hence cooled at different rates. The quicker cooling of the thin casting gave much shorter arrests in the cooling curve, indicating much less separation of graphite. The finer graphite of the smaller section accounted for the greater contraction. An examination of the cooling curves of two such bars would also clearly illustrate the extent of the stresses being set up in the casting, as one part would be seen to be expanding while the other would be contracting very considerably. The effect would be obvious.

MR. A. WILLIS, referring to certain castings mentioned by the lecturer (plates with heavy borders or rims, which warped on the rim being machined), said he would endeavour to regulate cooling by the disposition of the runners. Much could be done in such cases by using heavy runners on thin parts and light runners on thick parts. The lecturer had discounted, in remarks supplementing the Paper, the flowing through of extra metal to obtain a clean skin on the top part of the casting. He (Mr. Willis) contended that flowing through did give a cleaner and denser casting, as it carried away the dross produced by the eddies of metal in the mould.

MR. J. HALL asked for information as to the usual life of a chill or densener. In using these he had experienced considerable trouble with "blowing" after using about four times—so much so that the denseners had to be discarded after being used four times.

MR. A. R. BARTLETT said that it was good practice in large castings to flow metal through in order to prevent possible blowholes in the top part. As to the life of chills or denseners, he had had considerable experience in that matter, but had never seen blowholes resulting from their use, although using them 20 or 30 times. There was, however, a growth of the denseners which occurred on repeated heating, varying with the composition of the iron.

A MEMBER asked what action took place to make iron grow under repeated heating.

MR. C. G. BIRCHAM, referring to the Secretary's remarks, asked why large castings of the same composition contracted less than light ones. Also, how was a pattern-maker to apply his shrinkage rule if different sections contracted irregularly.

The SECRETARY replied that the greater separation of carbon resulting from protracted cooling decreased the total contraction compared with the same iron rapidly cooled. This was evidenced by the fact that a white iron, from which no graphite separated out, had a far greater contraction than a grey or graphitic iron. The pattern-maker would have to apply his shrink rule with due regard to the relative weights of the sections.

MR. D. GORDON asked whether an eliptical casting would contract to its separate centres, as an elipse had three centres.

MR. AITKEN, in reply to the chairman's remarks on contracting to separate centres, pointed out that the parts A and C in Fig. 1 were not immovable masses, but while contracting to their own centres were bodily drawn towards B as it contracted. As to Mr. Rolfe's comments on water in rust, red oxide of iron consisted of rust and water in crystallisation. Regarding chills as a panacea for irregular contraction, they were the best in some cases, but when used on iron low in silicon which required to be machined, would only produce wasters. Other methods of regulating contraction were rather indefinite As to Mr. Willis' remarks, he agreed in applying the runners to regulate the cooling. Flowing through, he admitted, would produce a denser casting, but would be a waste if the castings were only required to have a good skin and were not to be machined. It would not improve the skin, as even if the first skin formed were removed and re-formed, it would only be rougher on account of the coal-dust having been destroyed in the first skinning. Chills should not be of iron high in graphite. Growth resulted from the irregular expansion of the constituents and the formation of fissures which allowed oxidation of the metal and carbon. Replying to Mr. Gordon's query, the centre of an eliptical casting, from the contraction standpoint, was that portion which cooled last.

The CHAIRMAN, in thanking the lecturer for his Paper, stated that he had had trouble with chills causing "blowing." He found the best results were got by dressing the chills with dry plumbago.

Patterns Turned in Halves.

By W. J. Horner.

A large proportion of the cylindrical work done between centres has to be in halves for convenience in moulding. Flanges and other parts to fit on this are often turned separately on the face-plate, and must be in halves also. Such work cannot be turned solid and sawn through the middle and have its joint planed after, because the sawing and planing would reduce its diameter in one direction, and it would no longer be truly circular. This difficulty might be overcome by removing a definite amount and putting pieces on to make it up again, or in rough work the amount removed could be kept as little as possible and ignored. But there is no difficulty in fitting the halves and turning them after. It only involves the adoption of some means of holding them together and taking care to centre them properly in the lathe. On the face-plate the halves are screwed in the ordinary way, each half separately with not

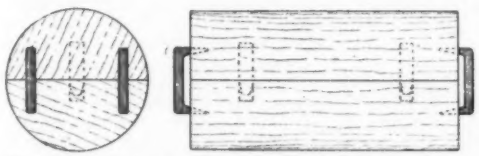


FIG. 1.—HALVES OF MOULDS HELD TOGETHER WITH IRON DOGS.

less than two screws and with the joints exactly on the centre of the plate. Between centres the halves must be well secured to each other before they are put in the lathe. This may be done with staples or dogs, as in Fig. 1, with screws, as in Fig. 2, or with centre plates screwed on the ends, as in Fig. 3. In large heavy work centre plates and staples are always used, and sometimes screws as well. Staples are always used when the diameter is large, to keep

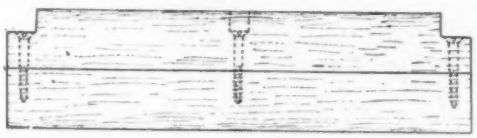


FIG. 2.—HALVES SCREWED TOGETHER.

the joint close at the edges and often they are used at intermediate points along the length, and are shifted from one place to another as the turning proceeds. In long work between centres, deeply-sunk screws, as in Fig. 2, are used at intermediate points, and are of a suitable length and sunk sufficiently to clear the tools in turning. Intermediate holes have to be plugged after, but screws at the ends come in the waste portions which are cut off after the article is turned. Notching down at the ends, as shown, is generally preferred to countersinking. Sometimes, in small diameters, neither is done, but the parts simply screwed together with the screw heads flush, and care is taken not to turn down on them with the tools. Centre plates are used for heavy work, even when it is not in halves, because without them there is risk of the work jumping out of centre, or even out of the lathe, owing to the softness of the wood and inability of the lathe centres to hold it securely and accurately. Metal centre plates screwed to the wood prevent this, and are an aid also in accurate centring at the commencement. For comparatively light work in halves, centre plates with prongs similar to staples, but shorter, are sometimes used instead of screwed-on plates, being more quickly attached. The ordinary centre plates are shown separately in Fig. 4. One plate is slotted for the fork centre and the other countersunk for the dead centre. These have to be set accurately on the joint or the turned halves will be unequal. The surface on which the plates bear may have to be levelled with a chisel, owing to the halves in the

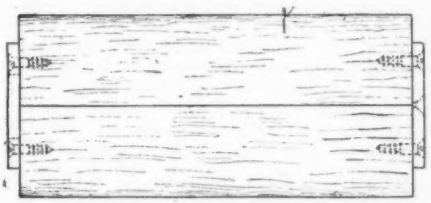


FIG. 3.—HALVES HELD WITH METAL CENTRE PLATES.

rough not exactly corresponding in length or not being sawn perfectly square. This is done if necessary with the halves dowelled or stapled together.

Halves are generally dowelled, and this, of course, is always done before turning The only exceptions where dowels are not used is in turning small portions in halves to be attached to the main pattern. Small flanges in halves are seldom dowelled, the

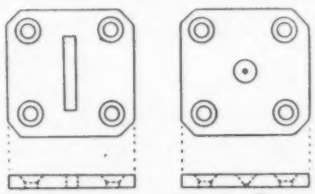


FIG. 4.—A PAIR OF CENTRE PLATES.

dowels in the main body of the pattern being sufficient, and the same is true of very short branches or extensions or prints in halves on larger dowelled bodies, which themselves may or may not be turned. The finished size and shape of the work has to be considered in placing the dowels. As they play no part in holding the halves together this is done by the ordinary methods, regardless of whether the parts are dowelled or not. In Fig. 1 wood dowels are shown dotted. Metal dowels of various kinds are commonly used, and, of course, the dowelling of parts is as common in bench as in lathe work.

The case often occurs of turned portions being wanted in slightly less than semi-circular halves—bosses, for instance, through the centre of which a rib passes, the pieces being fitted each side of the rib. Sometimes these are made at the bench instead of

turned, but if the boss has a fillet it is usually best to turn it in the lathe in a single piece and saw it to remove the amount not wanted, lines being marked to saw and plane to. Occasionally it may be more convenient to put a piece between, which can be removed after turning.

Cylindrical work with flanges is very common, and the flanges often make it necessary to halve the pattern for moulding when, if it were only a plain cylinder, a solid pattern might do, either moulded on end or on its side, according to its proportions. Flanges

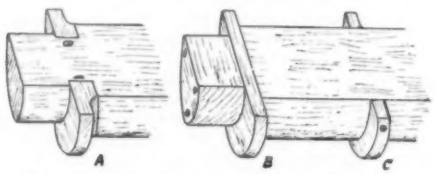


FIG. 5.—METHODS OF FITTING FLANGES.

are almost invariably fitted separately with their grain at right angles to the body of the pattern, as in Fig. 5. To turn them solid with the body would give short grain, and a very slight blow would break a piece from the flange. Moreover, a great deal of material would be wasted in turning the body down from a diameter large enough for the flanges. Flanges are nearly always turned with a fillet on the inner face, as in Fig. 6, and at A in Fig. 5, the usual method of fitting the flange to the pattern being shown in the latter view. It is done by turning a recess between print and pattern body and boxing the flange to fit. The width of the recess corresponds to the combined thickness of flange and fillet. The halves for the flange are prepared by jointing, and sometimes dowelling, and sawing to a slightly larger diameter than the flange has to be

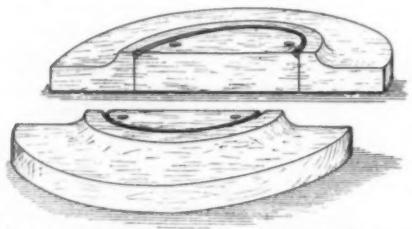


FIG. 6.—AN ORDINARY FLANGE WITH CENTRAL PART NOT YET CUT OUT.

turned to. Generally they are placed to thickness and put in the lathe only to turn the fillet and diameter and nick a circle for sawing out to fit the recess. It is quicker to saw this out and gouge it if necessary than to bore the flange in the lathe, especially in the case of large flanges. The flange in Fig. 6 is shown as taken from the lathe ready to have its central part sawn out. The screw holes shown are used to screw it to the face-plate. This avoids having holes in the flange itself. Often, however, screws are put through the plate into the flange and the holes in the latter are afterwards filled with putty or other stopping. Flanges occurring at intermediate positions on a cylindrical body would also have recesses turned for them in permanent work, but in a great deal of this kind of work alterations in length are being constantly made in the patterns and therefore the usual way is to fit intermediate flanges as at C in Fig. 5, generally with no fillet, as a fillet with thin edge would get broken. If fillets are wanted they are rubbed by the moulder. End flanges and prints are sometimes screwed on the ends of plain bodies, as at B, not in new patterns, but in the alteration of old ones. The flange at B might, and generally would, have a fillet solid across instead of cut out to fit round the pattern, as at A.

Fig. 7 shows how branches and extensions are attached in halved cylindrical work. Unless such pieces are so short that they can be screwed on, they

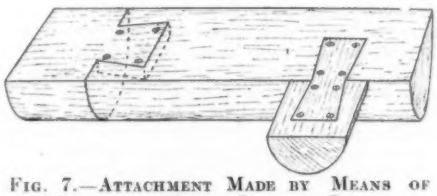


FIG. 7.—ATTACHMENT MADE BY MEANS OF DOVETAILED PIECES LET INTO JOINT.

are secured by a dovetail piece let into the joint, which piece may be solid with one part and screwed to the other, or may be made separately and screwed to both. In fitting the branch piece at right angles, the end of the piece must be gouged to fit the curve of the other. As there is no simple way of marking the curve of one on the curved surface of the other, the fitting is done tentatively, the main body being chalked where the fitting has to be done, and laid joint face downwards on a flat surface, and the end of the other, similarly laid, is approached to it to see where gouging is required, and then removed for that purpose, followed by another trial. A line is first squared across the joint of the piece to be gouged, to indicate the length of branch as measured from the edge of the main body, and this provides a line for cutting to. The exterior length which ends in a thin edge is also easily obtained by marking out

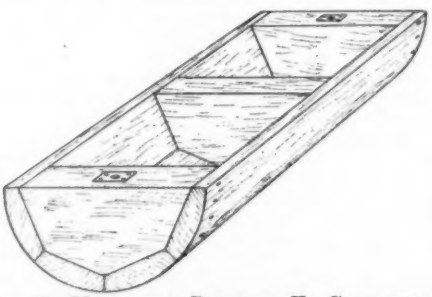


FIG. 8.—METHOD OF BUILDING UP CYLINDRICAL PATTERNS OF LARGE DIAMETER.

an end view of the main body and the piece fitted to it, and this length can be marked on the piece and care taken not to cut farther back.

Cylindrical patterns are sometimes so large in diameter that they must be lagged up, or staved up, as in Fig. 8. This is necessary partly to avoid shrinkage and distortion of the wood, partly for lightness, and partly to economise material. This method of construction is equally applicable whether the pattern is in halves or not, the only difference being that in one case the interior blocks are divided through the centre and the halves of the pattern built separately, while in the other the blocks are complete octagons or hexagons, or have whatever numbers of flats that may seem desirable to suit the diameter, and are lagged all round. In most cases

such patterns are in halves. End blocks are often thicker than intermediate ones and frequently extend to form solid prints. Half blocks are dowelled to each other before building up. Lags are generally glued and nailed to the flats on the blocks but sometimes are screwed. A full-size cross-section is first marked out on a drawing board, and on this the thickness of lags and number to the circle is decided. Eight is the usual number, but if the diameter is large more are used. With too few the lags would be thin at the edges or extremely thick in the middle.

Another class of work is that in which the halves are turned separately to fit each other, Fig. 9 being an example. The method of fitting the halves is by means of a central stud on one and a corresponding recess in the other, or alternatively there may be a

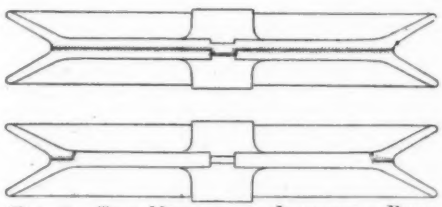


FIG. 9.—TWO METHODS OF JOINTING A ROPE PULLEY PATTERN.

shouldered portion, the same in principle as the stud and recess, but much larger in diameter, occurring near the circumference. Each of these methods, as shown in Fig. 9, which represents a rope pulley. The upper one is halved through the web or arms and has a small central stud to keep the halves concentric. If the pulley has arms it would be necessary to insert a dowel in addition to the stud, to keep the parts in one particular position in relation to each other. This, however, can be avoided by the method in the lower example, where the web or arms are solid with one-half the rim and the other half consists merely of a ring, so that although the joint in the bed of the rim is central, the pattern otherwise is not equally divided. The first method is suitable for a web, the halves of which have a substantial thickness; the second, when the web is very thin. The rim is built in segments and is quite strong either as a simple ring or with web attached. The bosses are fitted to the web with studs in a central hole, as is usual in all cases where bosses are made separately to go on the centre of a turned pattern.

A New Core Binder.

Under the title of "Foundrite," Messrs. F. C. Moorwood & Company, 7, East Parade, Sheffield, have placed on the market a binding material for moulding sand and cores which, they claim, supersedes and makes unnecessary all classes of core gum, linseed oil and all other binding material. It is said to renew old and burned sand, making it usable over and over again, to make cores unbreakable and the use of core irons unnecessary, and to leave the cores perfectly porous and not subject to shrinkage. The binder is supplied in liquid form ready for use, save for dilution with water.

The porosity of cores made with this material is said to be perfect, so that no blowing, cracking, crumbling, honeycombing or loss of strength can take place. The cost of using "Foundrite" for ordinary work is given as about one penny per gallon.

Queries.

Sulphur in Malleable Cast Iron.

What is the usual sulphur limit in pig-iron for malleable cast iron?—"MALLEABLE."

Answer.—This depends on the process adopted. In American or "black-heart" practice, where the annealing serves rather to precipitate than to eliminate the carbon, up to 0.07 per cent. is frequently recognised as permissible. A higher sulphur content makes the precipitation of carbon increasingly difficult. The specification of the American Society for Testing Materials quotes 0.06 per cent. as the sulphur maximum, and often lower than that is aimed at. In European, or Reaumur, practice, however, a much higher sulphur content is common, the product having a characteristic steely or "white-heart" fracture. One writer on the subject quotes analyses of iron with sulphur ranging from 0.145 per cent. to over 2 per cent., but in malleable practice it is highly desirable to keep the sulphur as low as possible. There are very few English pig-irons as low as 0.07 per cent. S., but there are many with from 0.15 to 0.40 per cent. A list of these was published in our issue of March, 1912. Those founders without much experience in malleable cast iron would do well to regard the latter figure as the maximum permissible and aim at the lower sulphur content.

German Silver.

Although German silver is generally understood to consist of copper, nickel and aluminium, I find that in some cases other metals, particularly aluminium, are used. What proportion of aluminium is generally employed?—"A. B. C."

Answer.—Copper, nickel and zinc are the essential constituents of German-silver alloys, but there are a number of "white metals" which pass under that name, though containing other elements, such as iron, tin, aluminium, etc. As regards aluminium, this is regularly added to the amount of about 3 per cent. to one mixture with a high zinc content, the object being, we believe, to counteract the oxidising tendency of the zinc. It also enables the mixture to cast well and gives a good white casting. About 0.10 per cent. of aluminium, also, is often added to an alloy of 50 Cu., 35 Zn., and 15 Ni., the aluminium being added in the form of a Zn.-Al. alloy. Aluminium is also added (about 2.75 per cent.) to copper-nickel alloys of, say, 65 Cu. 35 Zn., but these would hardly be classed as German silvers.

Machinery Depreciation and Income Tax.

In regard to depreciation and income-tax returns, there is a little difference of opinion, and we shall be glad if you will tell us if there is any definite limit laid down for the guidance of local officials as to how much depreciation is allowable on buildings, fixed machinery and plant, and other machinery and plant not coming under the previous heading. It is, of course, common knowledge that the bulk of the lighter machines in an engineering shop have nowadays only a life of from 5 to 10 years at the very outside, even allowing for their value when disposed of as scrap or second-hand machines, and we understand that in some cases the depreciation allowed upon these for businesses doing daily work only is a good deal higher than the Assessor here appears disposed to grant.

"A. C. C."

Answer.—An appeal to the District Commissioners in this case would seem advisable. The subject is dealt with to some length on page 739 of this issue, under editorial "Notes and Comments."

Foundry Progress.

Address before Newcastle Foundrymen.

The annual meeting of the Newcastle and District Branch of the British Foundrymen's Association was held on October 31, when the newly-elected President, Mr. J. M. Weir, delivered his Presidential address, an abstract of which is as follows:—

The country is at present under a cloud so dense that even the wisest cannot discern the far-reaching problems or foretell the ultimate results of events. Science and art are brushed aside for the time being, and the sword has pre-eminence over the pen. But I am not pessimistic nor do I consider that we as a nation have lost our place in the world's commerce and industry. We are ready to go forward and try and solve the problems which beset us in the factory, realising that England must hold her place in the trade of the world. There never was a better opportunity for employers to secure that position, and it behoves each one of us to do our part in that direction. Years ago, we were told that Germany and other nations were far in advance of the British nation in producing high-class castings. Perhaps that assertion was right, but it must be remembered that the German Government subsidised all efforts to promote research. Many of our members have wondered why employers have not more readily entered into co-operation with the Foundrymen's Association where the various sides of business are discussed and an effort made to solve the difficulties that present themselves day by day. We have trials and disappointments in foundry life, and unless we are encouraged, failure will stamp our path.

Whatever good may come out of the present war, the British iron, steel and engineering industry stands to get the most. It is one of the essentials that our members watch with great care the tide of trade. In calculating possibilities it is most important to observe that Germany's rapid progress in manufacturing production, and the exportation of manufactures, her persistent underselling of the British and American in the world's markets has been due not only to her low prices but to the extended credits her manufacturers and merchants have conceded. If, therefore, a serious blow is to be struck at Germany's industry, her commerce will suffer, and to a corresponding extent England and America will benefit. This is a matter of highest interest to those engaged in the steel and iron trades, the commercial group in which above all others Germany has offered the most serious competition in late years. The relief from this competition cannot help but be reflected in a substantial revival of British industry. The iron and steel foundries must of necessity play a very important part in providing the heavy machinery that was at one time designed and made by Continental firms. The organisation set up by the Board of Trade will no doubt be fully utilised by British firms, and the results should be a considerable expansion of our home and oversea trade.

Some time ago on Tyneside we were told that we could not produce cast iron homogeneous enough to suit the Diesel oil engine. That idea is now gone. The Wallsend Slipway and Messrs. Doxford, Sunderland, have demonstrated what ironfounders can produce on the North-East Coast. A very large proportion of H.M. ships received their engines from our midst, cast on Tyneside, and these engines go through very vigorous inspection and test. The standard required is 11 tons to the square inch, and 15.6 was obtained by firms engaged on Admiralty work. German cast iron is a long way inferior, as some of the analyses showed on a recent inspection. Let us, one and all, still improve on our standard. Encouragement can be given by employers and managers in offering prizes, and I earnestly hope that our branch of the British Foundrymen's Association will endeavour to promote that interest in the foundry and raise the status of our workmen. Let us recognise that the apprentice of to-day is the journeyman of to-morrow. We all know that by increasing the interest of our apprentices we shall be sowing that which will yield a rich blessing not only to ourselves but also to the State. If we could only influence our employers to build us a place on Tyneside as a practical workshop, where the apprentices could attend and receive technical instruction as well as practical knowledge, it would be money well invested.

There are many methods we might imitate from German employers. One is in regard to the training of the foreman or overseer. German employers make it compulsory for their managers and overseers to have a thorough technical knowledge, so that they may keep up with current developments. To acquire this they must attend one of the many institutes at their disposal at least two sessions—one preliminary and one advanced. The first lays great stress on mathematical calculations and fundamental laws of physics and mechanics, the production of raw material, and a thorough knowledge of the analysis of various pig-irons. The second course covers the manipulation of labour, laws and safety provisions. I might here commend to all our foremen the safety of the workmen under their care; also the question of lighting of shops.

I would like our young men to aim high, to decide that though they may feel they have barely their foot on the ladder of success they will do their utmost to climb it. A lofty aim is inspiring. It is better to aim high, even if one does not reach the mark, for in that way one will go higher than is possible by aiming low. Singleness of purpose, untiring work, ceaseless application, undaunted courage, have their reward.

Mr. M. E. Gallon (senior Vice-President) referring to a phrase in the latter portion of the address, remarked that by aiming high one would undoubtedly reach somewhere near the mark, and that if all the masters in the trade could be got to aim high, there was no country that could produce better men than England.

Mr. E. Smith referred to the many difficulties that ironfounders had to confront. Time after time they were cut out by German competition, but now they must show the world that they could do equal if not better work than Germany.

Mr. S. W. Wise, of Heaton, referring to the question of Diesel oil engines, said castings were made in England six or eight years ago for Diesel oil engines, and the man responsible for them was living on Tyneside at the present.

Moulding a Fly-Wheel with Strickles and Core-Boxes.

Before the Halifax and District Branch of the British Foundrymen's Association on November 14, Mr. J. G. Robinson gave an address on the preparation of a mould for a fly-wheel by the use of strickle boards and core boxes.

Mr. Robinson said the particular wheel which he had chosen for illustration was 8 ft. diameter, 24 in. wide on the rim and weighed about 13 tons. It was cast in halves and machined on the joint, and was fastened together by means of bolts through the boss and dowel pins and cotters in the rim. Barring-gear teeth were cast on one side of the rim. At one time a fly-wheel of that description would have been cast one-half at a time, but the mould could now be struck up for the whole wheel, and by using splitting cores both halves could be cast at one time. In order to do this it was necessary to increase the distance across the diameter in one direction to allow for the amount taken out by the splitting cores. This was done by using two spindles fixed at 7-in. centres. This distance could be varied to suit any special requirements. Originally they had been fixed at 3-in. centres, but when the machining allowance was reckoned off on either half and the splitting core space between floor sand would do, as it only formed a seating for the arm cores. The method of placing facing sand to form the outer diameter of the rim is shown on Fig. 2.

The strickle board was fixed on the spindle and a ring of facing sand about 4 in. deep placed as shown. The remainder of the bottom was filled with floor sand, and this formed one ram. The part towards the centre need only be trodden, but from the ring of facing sand to the back must be firmly rammed. This operation was repeated up to the joint level, which gave a ring of facing sand corresponding with the periphery of the wheel.

Fig. 3 showed the joints strickled off with a dummy board which made the shape exactly as if a pattern was in the floor. At the places where there were shoulders on the sand, pieces of paper were placed sprinkled over with water to make them bed down into the corners. By doing this a cleaner lift was got with the top part. Parting sand was then dusted all over the surface, the places marked for two runners in the boss and four risers on the rim. Round pegs were fixed in those places, and the top part of the moulding box placed on, guide stakes being

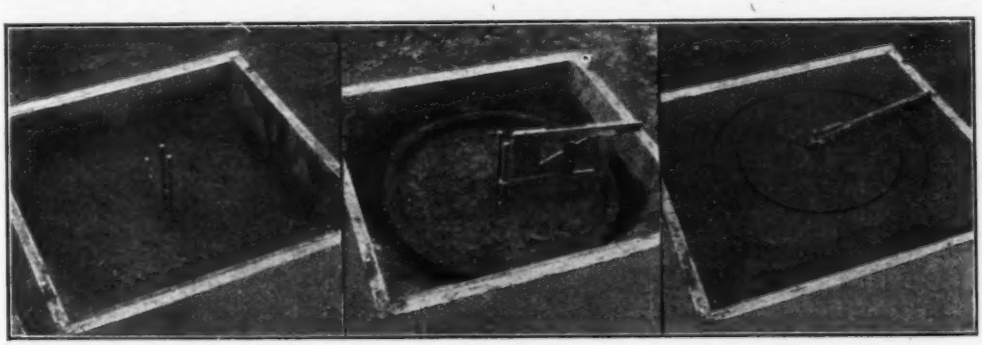


Fig. 1.—Hole with Spindles in Position. Fig. 2.—Strickles in Position; First Ram. Fig. 3.—Joint Struck Off for Ramming Top Part.

made in two parts it left rather a delicate core and very little space for a core grid. By using the 7-in. centre there was room for a good strong grid, and a firm core was obtained. The mould for this wheel was struck up in sand and dried.

At this point Mr. Robinson drew attention to the fact that a lot of the strickle work that was made in loam could be done more profitably in sand, because less tackle in the shape of plates and bricks was required in the first place and the consequent clearing away after the job was cast was saved.

Fig. 1 herewith shows the spindles fixed in the centres and the hole dug out to the required depth and about 6 in. larger all round than the diameter of the wheel required. In any mould for a weighty casting, said the lecturer, it was necessary to have facing sand on the faces which came into contact with the metal. In this case the places where the metal came into contact with the bottom were on the face of the boss and the rim. At these points facing sand was placed and well rammed, but in the driven in. The box was gaggered and rammed up, leaving two spaces to be used later for drying purposes.

Fig. 4 shows the top part removed and the bottom part strickled out to the required shape. This was first dug out about 1 in. smaller than was required, and then scraped off with the board. By ramming up a ring of facing sand in the first place, a firm back and a suitable sand for the face of the mould had been obtained. After strickling to shape the mould was finished with a cork rubber and the part which formed the face of the boss and also the parts where the ends of the arms would come were well sprigged. The larger diameter of the mould shown on the joint formed the seating for the cores for the barring-gear teeth. Before blacking, the joint lines for the wheel halves were marked off with a straight-edge, which fitted the spindles. Prints for the centre core and splitting core and also for the splitting core on the rim were bedded in and the whole well blacked, sleeked, and gum washed, after which it appeared

as in Fig. 5. This shows the top part turned over and finished in a similar manner.

The mould was now ready for drying. This was done by placing the top part over the bottom, but packed up the thickness of a brick from the joint. This allowed the heat to dry the joint face. As regards the coremaking. Fig. 6 shows the box for the arm cores, the lifting grid and two finished cores. All the six cores were made from the same box, two of them being plain, two right-hand for the joint and two left-hand. The box was made so that right and left respectively were obtained by turning it over when commencing to make the cores, the only difference in the cores being that the lifting staples in the grid were the opposite way in. The sides of the box and the boss were fixtures, the parts forming the back and also the arm being loose. In the making of these cores as much space as possible was filled with ashes and straight irons were placed over

The mould having been dried, the top box removed and the bottom swept out, the spindles were again fixed in position and the operation of fixing the cores commenced as shown in Fig. 8. The first cores to be placed in position were the arm cores on each side of the joint. These were set to the joint lines mentioned when finishing the mould, and also fitted against the shoulder shown on the bottom. In addition to this a distance piece was tried between the outside of the mould and the back of the core to ensure the width of the rim being correct. The next cores fixed were the splitting cores for the rim. These fitted between the arm cores and into the seatings provided by the prints which were bedded in when preparing the mould. The cotter core had a bearing on the bottom of the mould and assisted to hold the whole core perpendicular. To ensure the round dowel cores being in line, a template was used, which fitted on the flat part of the splitting core, the rim

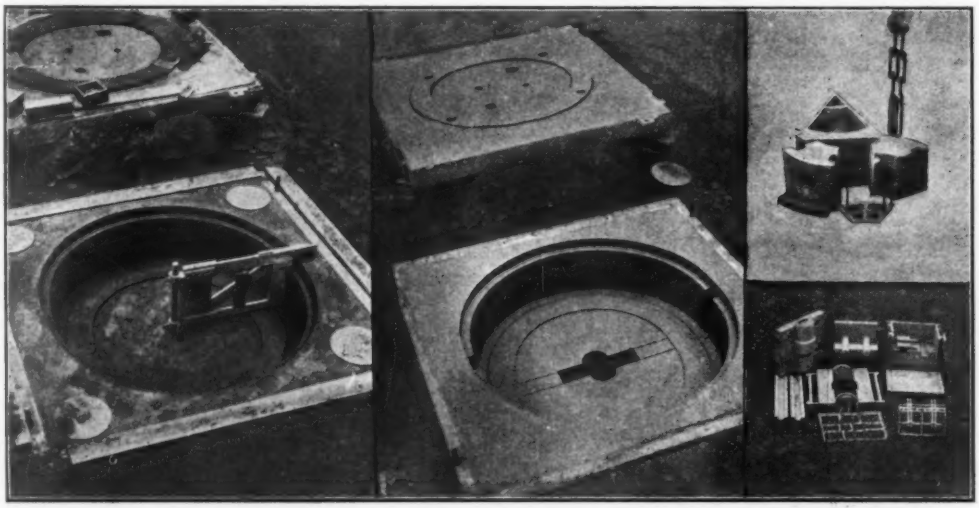


Fig. 4.—Mould Strickled Out.

Fig. 5. — Bottom Finished, showing Core Prints; also Top Part.

Fig. 6.—Arm Cores, Core Box, and Teeth Cores.

Fig. 7. — Splitting Cores.

the part forming the arm. At the point where the arm end joined the rim it was sprigged and well vented, because the metal being poured into the boss had to run through, and had a tendency to cause scabbing at this place. In finishing the cores they were well coated with wet blacking, and whilst moist were dusted over with plumbago, which was well rubbed in.

The lecturer here drew attention to the lifting staples, which had a certain amount of straight along the top. By using clam hooks attached to screw hooks any adjustment necessary could be got. The other cores shown were for the barring-gear teeth, and were made in segments.

Fig. 7 shows the cores used for splitting the boss and the supporting grids. Those for splitting the boss carried half of the centre core, and had seatings for the bolt-hole cores. Those for the rim carried the round dowel cores, and also the cotter cores. Since the cotter cores passed through the whole width of the rim they were made ¼ in. thicker in the centre than at the ends. This allowed for nip on the core and saved trouble when fixing the cotters in the finished casting. The vents from all these cores were conducted to the place where they joined the arm cores when being placed in the mould.

and alongside the dowel core. The four cores were set in like manner, after which the teeth cores were fixed in the seating which was strickled on the top edge. These were set true on the inside edge to a staff, which fitted the spindle and gave the distance from the centre to the face of the tooth core. The spindles were then removed, the sockets filled with greasy waste, and the holes rammed up with sand. The centre splitting cores, which had been previously cramped together, were now fixed into the seatings provided. The round bolt-hole cores were threaded through and took a bearing at ends in the arm cores, where the vents were connected by means of wood-wool bands to the ashes mentioned when making the arm cores. The vents from the splitting cores in the rim were connected in like manner, and the two remaining arm cores fixed in position. All the joints were then patched, blacked and dried with a lamp, and the spaces shown between the arm cores filled with ashes to within 2 in. of the top. A plug about 3 in. diameter was placed in and the remainder rammed up with sand. When this plug was withdrawn there was an open space to the ashes in the vents. Whiting was then sprinkled on all places

where the top part was required to take a bearing, and also round the vent holes in the arm cores, when the mould appeared as in Fig. 9.

The top part was then lowered on and lifted off again, and holes cut through to match the vents, the position of which was shown by the marks from the whiting. Having made sure that all bearing surfaces were correct and that no crushing had occurred, the risers were covered with clay, the runner pegs fixed and the top lowered on for the last time. Wood-wool bands were connected to the vents and the hole then rammed up with sand. When the runner bush was being made up, a loam cake was placed on the bottom for the metal to drop onto from the ladle. The runners were covered with pieces of tin instead of plugs. Large riser bushes were made up, the top weighted and stopped in at the joints, when it appeared as in Fig. 10, ready for casting. After casting it was fed down both runners and all four risers. Fig. 11 shows the finished casting.

an eccentric spindle and using two spindles (and these spindles could also be used for other work, where only one spindle was required).

Mr. Berry said he personally preferred patterns. A lot of the flywheels made could be made in half the time if patterns were used in place of strickles, and it was a cleaner way of working. He would like to ask why face sprigging was resorted to at the arm ends and the shoulders opposite the arm ends. The lecturer had said it was here that the metal ran over during the time the mould was being filled; but he (the speaker) had always been given to understand that a dry-sand mould would stand practically anything. They cast at their works jobs weighing ten tons in green sand without face sprigging. He did not see any advantage in the lifting tackle, he was always partial to three round-headed lifting staples, and three screw hooks; three screws could then be used to get whatever balance was required.

Mr. Robinson, in reply, said the reason why they face-sprigged certain portions of the mould was on

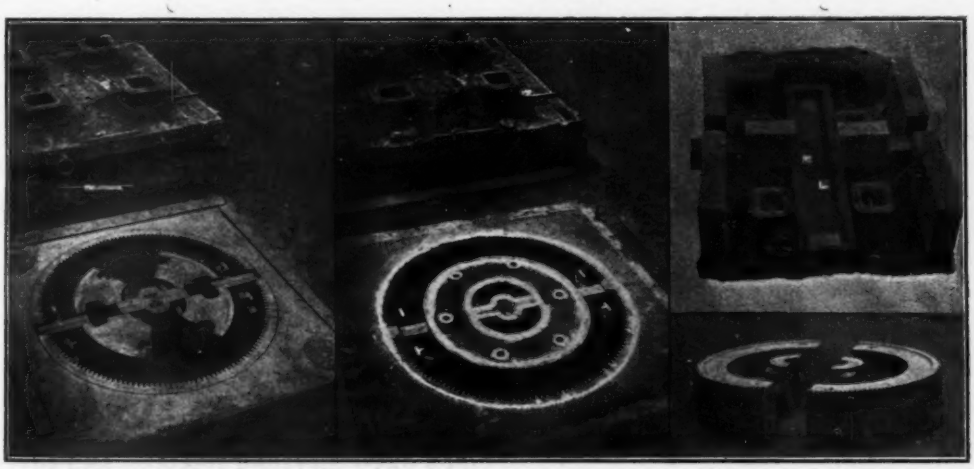


Fig. 8.—Mould partly Cored. Fig. 9.—Finishing Coring. Fig. 10.—Ready for Pouring. Fig. 11.—Finished Casting.

Discussion.

Mr. Campbell said the illustrations showed the spindles in position, but did not show what they were fastened to nor the method of fastening.

Mr. Robinson said the spindles used were ordinary round spindles tapering off at the bottom. These fitted into a cross with suitable holes bored for the spindles. The arms fastened on to the spindles and the spindles revolved. In some shops the spindle was a fixture and had a collar attached to it. The arms only in that case would revolve.

Mr. Harrington said he did not altogether agree that using two spindles was the best method in such cases. He had seen various methods, and where he worked at the present time they used eccentric spindles which left an opening of 6 in. for the splitting cores. This saved the necessity of changing the sweep from one spindle to another, and he thought that was an improvement on the use of two spindles. Another method he had seen which saved digging out the hole twice, was to pass a segment round and ram it up that way.

Mr. Robinson replied that he was quite conversant with both the methods mentioned, but it was cheaper from the point of view of patternmaking to make a strickle board than a block, and really he did not think there was much to choose between the use of account of the sand. They only used one portion of new sand to four of old sand. He had seen dry-sand moulds where nothing but new sand had been used, and he thought that was too expensive. They did not spend one shilling in new sand where some firms spent five. A few sprigs made all the difference. In respect to the lifting tackle, the arm cores in question did not readily lend themselves to the use of three lifting hooks because the arm itself took away the middle of the core. By using the flat-topped staples and double-clam hooks they were very easily brought to a balance and safely carried. With regard to Mr. Berry's objection to the use of strickles, they could not possibly go to the expense of making patterns for these large wheels. They might make a wheel 8 ft. 6 in. diameter weighing 13 tons one day and the next wheel of the same diameter might only weigh six tons. If they had a pattern for the 13-ton wheel it would be useless for the wheel weighing 6 tons.

Mr. Midgley, speaking as a patternmaker, said he thought for large wheels strickles were preferable to patterns. At their works they had models up to 8 ft. 6 in. diameter. They had had the opinion of successive foremen in the foundry, and the result was they scrapped those over 7 ft. diameter. One of

the great difficulties when these iron models had been used was to jar them at all so that the moulder could get a decent lift.

Mr. W. Smith said they made a lot of wheels at their works, but none under 10 ft. diameter, and they had not a pattern about the place. Some of their rope pulleys were made in green sand. The method used was that of passing a segment round, and skin drying the moulds before casting. The larger sizes were built up. In all cases the tops were covered by loam plates.

Mr. Campbell said he was of the opinion where a number of wheels had to be made of any given size and weight the use of a pattrn was the better and cheaper way up to a certain point, when they became too large to be conveniently handled. Then it was better to use the strickle.

Discussion at Newcastle-on-Tyne Branch.

Mr. Robinson also lectured on the same subject before the Newcastle and District Branch on November 28, Mr. J. M. Weir being in the chair.

The Chairman said he would like to know the amount of time it took to make the wheel.

Mr. Robinson said it would take about four days to make a wheel weighing 13 tons, with dimensions 8 ft. by 2 ft. 4 in.; *i.e.*, two men would be employed about three days with the preliminary work, etc., including digging out the hole, fixing spindles and strickle, staking, fixing runners and risers, gaggering, etc., and ramming up again, together with the fixing of the necessary portable stoves, then after leaving to dry overnight, removing top and fixing cores, etc., perhaps requiring a little help to get the top part and bottom finished. The fourth day would be needed to finish the work.

Mr. Weir was of opinion that work struck up in sand on the floor would be a quicker and cheaper job than striking it up in loam. Furthermore, on the North-East Coast it would be unnecessary to employ two men on the wheel for the whole period, as apprentices could certainly do the strickling in.

Mr. M. E. Gallon remarked that for one wheel he had not the slightest doubt the lecturer was right in saying that it would be much cheaper by his method, but when two or three wheels had to be made, it could certainly be done as quickly in loam. He also thought that in making the top, instead of doing so in the method mentioned in the lecture, he would ram a flat top, leaving a space for two pins to go up through the top. In his estimation the job could be done in much less time by that method. Concluding, he asked the lecturer why irons were put over the arms? Was it to strengthen the core or was it to make the arm safe; also, what sand was used?

Mr. Edward Smith said that where a lot of the wheels were to be made a block pattern would be a good deal cheaper. The sand used in the Newcastle district was mostly loam sand, although the rock sand was coming more into use owing to the collieries selling it cheaper. Undoubtedly it swept and faced very much cleaner than the clay-laden sand. However, speaking on the method in general, he did not think it advisable to adopt in that district a method so entirely different from their own.

Mr. Robinson, in replying to Mr. Gallon's remarks, said that in Halifax they never made a number of exactly the same wheel, and very probably the next wheel would only weigh about six tons. As a rule, 7 ft. 6 in. was the largest diameter required. Up to that cast-iron patterns were used. They made three or four in a year, using these cast-iron patterns. The reason irons were put over the arms was to strengthen the core. With regard to the question of facing sand, and the quality used in Halifax, they used Doncaster sand, a light red sand, which, he understood, was not a great deal different from the sand used in the Newcastle district.

Mr. Richardson said that, as the lecturer had remarked during the evening, different methods were used in different districts. They, on the North-East Coast, were mostly concerned with loam work. He, however, thought that sweeping in loam was just as efficient, and just as cheap as making it in half loam and half sand. Also, they had the bricks in the shop, together with all sizes of plates in stock, so that he did not think it would make a great deal of difference.

Mr. Robinson, referring to Mr. Richardson's statement that he could make in loam as cheaply as in the shop, said that the chief reason was not that it was so much handier, but simply that it was what they had been used to.

A vote of thanks to the lecturer concluded the meeting.

TESTED FOUNDRY SANDS.—Too much stress cannot be laid on the importance of getting reliable sand in the foundry; for in the face of the general ignorance of sands' properties which prevails in the trade, coupled with the inevitable variations in the composition of natural sands, it is extremely difficult for the founder to ensure the standard being maintained regularly. It is interesting to note, therefore, that with a view to meeting each founder's special requirements, Mr. A. L. Curtis, of Chatteris, the well-known sand expert, is preparing sets of samples of numerous sands for different purposes and sending them out to foundry-sand users and others interested, so that they may choose the most suitable for their work and order accordingly. Each of the sands has been specially tested and is labelled with the laboratory number and the description of work for which it is suitable, and in ordering it is only necessary to quote the number. The samples cover a very wide range of work, from core-sands to moulding-sands of all descriptions for brass, iron, steel and malleable cast-iron, and sand-blast purposes.

"FIRE AND BLOW-BACK INTERCEPTER" FOR OXY-ACETYLENE WELDING AND CUTTING PLANTS.—More or less serious explosions with the oxy-acetylene plant, as now so extensively employed for cutting and welding, are by no means uncommon. The explosions take place in the hydraulic valves; being usually brought about by a slight back-fire in the blowpipe which has a tendency to divert the oxygen back through the acetylene tube, with the result that the water is blown either through the filling tube or back into the generator. In the meantime, the oxygen and acetylene being together, combustion takes place which eventually reaches the (by this time) empty water seal, and the resultant explosion

may quite easily have serious consequences. Messrs. Samuel Crabtree, Limited, Kilnhurst Works, Todmorden, themselves extensive users of the oxy-acetylene system, have evolved the simple device illustrated to overcome the trouble referred to, and as the result of their experience with it claim that with its use it is impossible for any explosion to pass the valve. The appliance consists of a brass shell with a nipple at each end to connect to the rubber acetylene tube. Inside the shell is a sensitive rubber pulse valve, consisting of a rubber tube flattened at one end which allows the acetylene to pass freely in the right direction, whilst it is impossible for the oxygen to blow back. An extra precaution is the insertion of a very fine wire gauze, which prevents any possibility of the fire getting beyond this point.

Modern Testing Machines.

No development of modern engineering better illustrates the reliability and high efficiency of British machinery than the rapid evolution of devices for testing constructive materials. Nearly every big modern foundry and engineering plant employs its own works' chemist as a matter of course, but the most notable of all developments is to be found in the high scientific efficiency of the modern metal-testing machines employed. The up-to-date engineer not only personally checks the formulæ and actual composition of his metals and alloys, but also tests the mechanical behaviour of his own castings, machine parts, etc., under tensile stress, compression, transverse stress (this latter being now the rule for cast iron), shearing, torsion, hardness and impact tests in order to arrive at the true factor of safety.

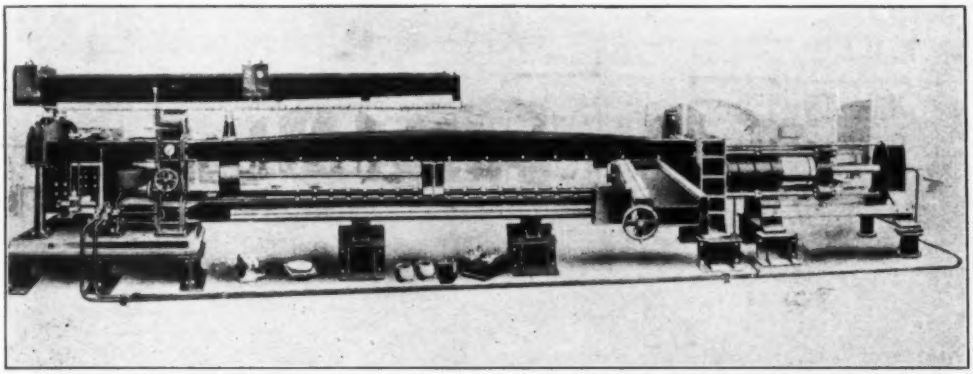


FIG. 1.—100-TON UNIVERSAL TESTING MACHINE AT GLASGOW AND WEST OF SCOTLAND TECHNICAL COLLEGE.

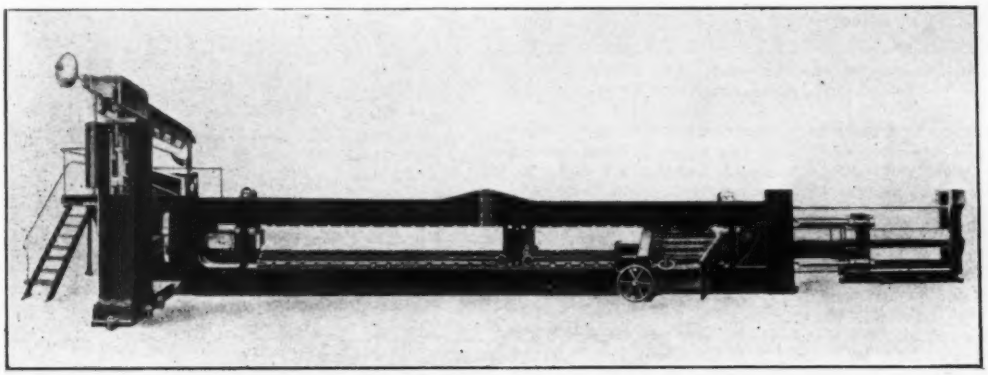


FIG. 2.—300-TON TESTING MACHINE AT BIRMINGHAM UNIVERSITY.

British engineers are well served in the matter of testing machinery, for even if they do not possess testing plant of their own, elaborate machines are available at many of the principal manufacturing centres. An interesting example is the 100-ton testing machine supplied by Messrs. W. & T. Avery, Limited, of Soho Foundry, Birmingham, and installed at the Glasgow Technical College (Fig. 1). This machine was designed to meet the requirements of Professor Longbottom. The scheme consists of three separate machines, all of which embody distinct features. The principal machine is a 100-ton horizontal testing machine, designed for tensile, compression, bending and shearing tests. A tension-torsion testing machine was also supplied for applying both these tests either simultaneously or separately to a bar specimen, together with a machine for reverse-torsion testing in either direction of twist.

The 100-ton machine, shown in Fig. 1, will test specimens in tension up to a maximum stretched length of 15 ft. 6 in., and test in compression columns up to 15 ft. Transverse tests can be applied to beams having a maximum span of 15 ft. The shearing tools admit specimens of 4 in. by 2 in. section in double shear. The frame consists of four substantial struts supported by vertical standards, the entire machine being quite independent of the foundation for its stability. A locking device is provided, by the use of which specimens may be kept under strain for a protracted period.

Special interest attaches to the weighing or recording system, which is arranged at the left of the bed. The poise is divided into three parts in order to obtain long units of scale for the lower loads. The finer sub-divisions are obtained by means of a vernier upon the poise, which indicates one-thousandth parts of a ton. The knife edges of the main levers are all proportioned to give a length of not less than 1 in. for every 5 tons of load. To provide against injury to the knife edges at the moment of recoil

when the specimen breaks, the shock is received upon two adjustable collars, placed immediately behind the lock nuts of the tension cross-head.

Birmingham University possesses a still larger machine, capable of applying a strain of 300 tons, also manufactured by Messrs. Avery. This machine (Fig. 2) has an overall length of 67 ft. 9 in. The maximum stretched length for specimens under tension test is 33 ft. 6 in. Columns and stanchions up to 30 ft. can be tested in compression. Complete roof principals can be tested up to the maximum load of 300 tons, the strain being applied centrally between abutments set to a span of 20 ft. in maximum. To avoid the use of loose weights, a steelyard arrangement of seven poises has been applied, each of which, when moved out to the full length of the steelyard, represents a load of 100,000 lbs. upon the specimen. Each poise may, by the rotation of a milled knob at the front, be engaged or disengaged with a screw placed between the parallel blades of the steelyard. The screw is revolved by means of a gearing which is in connection with a shaft fixed parallel to and at the front of the steelyard. This shaft, having a hand wheel at each end, enables the

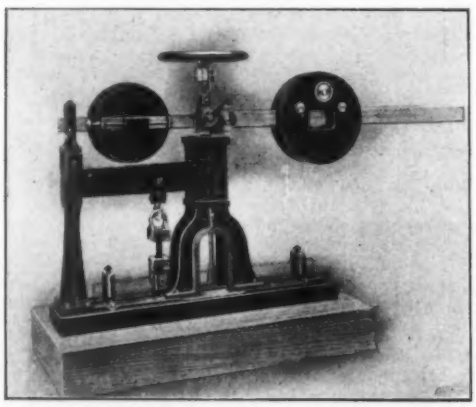


FIG. 3.—COMBINED TENSILE AND TRANSVERSE TESTING MACHINE FOR CAST IRON.

operator to move the poises whilst standing at either end of the steelyard, and operation is thus carried forward to the other poises in rotation till the fracture takes place. By this means a steadily increasing strain is applied, whilst the steelyard is in uninterrupted equilibrium throughout the test.

Each poise has a vernier working in conjunction with its own graduated scale upon the steelyard, so that sub-divisions of 10 lbs. are obtained from zero up to the full load of 300 tons. Attached to the steelyard column is an autographic stress-strain recorder, which, by means of connections to the specimen and the gearing by which the poises are propelled, permits of stress-strain diagrams being taken. The strain is applied by means of a double-acting hydraulic cylinder, worked by an accumulator supplying water at 1,000 lbs. per sq. in. pressure, the return stroke of the ram being obtained by means of the town supply of 85 lbs. per sq. in.

To meet the demand for a small, handy machine suitable for engineers to install in their own works, the same firm designed a combined tensile- and transverse-testing machine (Fig. 3) for cast iron. The tensile capacity of this machine is 60 cwt., and the transverse capacity 50 cwts. Specimens up to ½ in. diameter can be subjected to a tensile strain of 80 cwts. For transverse tests the machine is designed to test bars up to 2 in. by 1 in. section, up to 36 in. between centres. By means of a micrometer deflection scale the variation of deflections of the specimen under different strains can be ascertained during the test by gradations of $\frac{1}{1000}$ in. The strain is steadily and evenly applied by means of a hand wheel as shown, working through a steel stirrup, which transmits the strain to the specimen. As the specimen fractures, the shock is absorbed by a spring buffer fitted on the steelyard carrier.

Fig. 4 shows a machine by the same makers for impact testing. That iron or steel which has passed all ordinary statical tests will sometimes fail in service is admitted, and this failure has been conclusively proved to be due to lack of shock-resisting

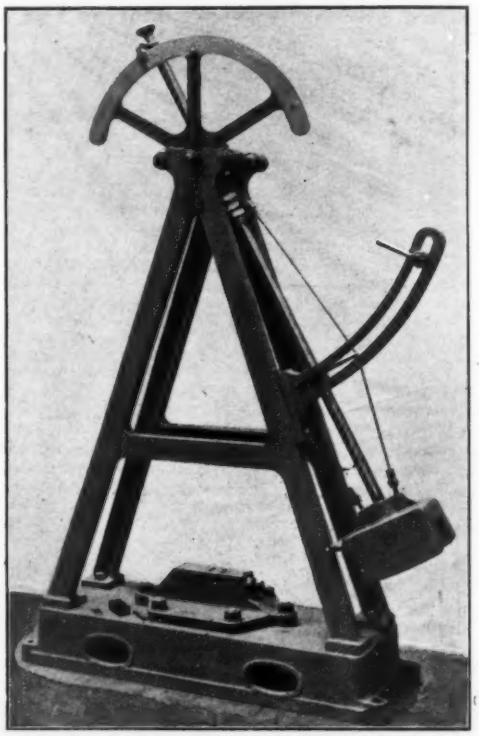


FIG. 4.—IMPACT-BENDING TESTING MACHINE.

qualities which cannot be investigated by means of the tensile test. Probably the oldest workshop test in existence consists in notching a bar and then laying it over an anvil with the notch uppermost and striking the end until either fracture or bending takes place. The impact-bending tester shown accurately registers, without calculation, the foot pounds of energy absorbed by a notched test piece of standard size and shape when broken by one blow from a swinging pendulum. An unskilled operator can make tests at the rate of 100 per hour, and the chances of error are practically eliminated.

The advantages of combining the ordinary tensile and impact-bending tests are obvious; not only the resistance to static or dead loads is obtained, but also the resistance to shock on suddenly-applied loads. This information enables the designer to use materials which are most suitable for machines or structures which have to stand shock.

"F.T.J." Bookshelf.

The Raw Materials for the Enamel Industry. By Julius Grünwald; translated by Herbert H. Hodgson. (London: Charles Griffin & Company, Limited, Exeter Street, Strand.)

The industry of enamelling on metals is one in which remarkable strides have been made during recent years, perhaps more in Germany than in this country. It is not that British goods are inferior, for in many cases the reverse is the fact, but Germany has certainly tackled the problems of the industry in a more business-like manner than many of our manufacturers have done. Therefore, coming at a time when all eyes are turned to any opportunity to capture German trade, this book should be heartily welcomed. Dr. Grünwald is one of the best-known authorities on the subject of enamelling on metals, and his previous volumes, "The Theory and Practice of Enamelling on Iron and Steel," and "The Technology of Iron Enamelling and Tinning," were recently translated into English by Mr. Hodgson, who now adds the present volume on the raw materials and their chemical technology. The previous volumes have already been reviewed in our columns. To most manufacturers, chemists, and enamel technologists the presentation of this translation will be very helpful, for the information it contains is by no means as generally possessed in the trade as our position as a competitive nation would justify. The composition and properties of the raw materials of enamelling are concisely discussed by the author, who then takes up the various colouring agents. Tin oxide naturally receives careful consideration as being of fundamental importance in the production of white enamels, and then possible substitutes for tin oxide are dealt with. Nickel oxide, cobalt oxide and compounds, soda, saltpetre and potash in turn come under consideration, and the author then devotes a chapter to some important enamelling pigments. The final chapter is concerned with general enamel recipes and similar information. In the 220 pages occupied by the book a lot of most valuable information on this branch of enamelling is given, without undue verbiage such as would render it unwieldy for the practical man.

Catalogues, etc.

Alldays & Onions, Pneumatic Engineering Company, Limited, Birmingham.—This Company's latest grindstone list deals with "Paragon" grindstones of various descriptions, including trough stones for power and manual drive, stone and trough mounted on wheels, a stone for large work with horse for seating the operator, motor-driven stones complete with motor on one bed, grindstone dressers and other accessory fittings and appliances. The list is full of really useful information on grindstones, while the range of requirements met by the apparatus shown is very considerable.

The British Aluminium Company, Limited, 109, Queen Victoria Street, London, E.C.—A re-issue of this company's pamphlet No. 130C on electric power transmission by aluminium conductors is illustrated by photos of a number of important installations of aluminium transmission lines. The treatise has been revised to bring the matter into line with the regulations existing in various countries (which, it may be noted, vary considerably), and, among other things, have been added a table of safe currents for overhead aluminium conductors, on a basis of temperature rise, and matter dealing with line regulation, erection, scrap value, etc.

THE members of the South Staffordshire Iron and Steel Institute met at Dudley, on November 21, when Mr H. Brearley read a paper on "Steel Castings."

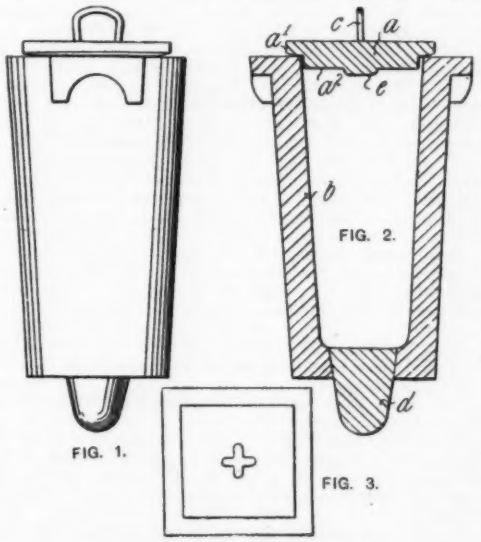
Inventions.

An asterisk indicates that a complete specification accompanies the application. When inventions are communicated the names of the communicators are in brackets.

21,636. Furnaces for melting brass. I. Hall.
21,685. Construction of apparatus for casting tin. F. C. Bell and Cornish Tin Smelting Company, Limited.
21,720. Sand for moulders' use. A. N. King and F. Holmes.

Abstract of British Patent Specification recently Accepted.

12,546 (1914). *Ingot Moulds.* E. Lewis, 50, Manselton Road, Manselton, Swansea.—Fig. 1 is a side elevation of an ingot mould fitted with the improved form of cover; Fig. 2 is a sectional elevation of same taken in a plane at right angles thereto; and Fig. 3 is an inverted plan view of the improved mould cover. The cover *a* of the mould *b* is formed with the usual flange a^1 adapted to engage the upper edge of the mould, and to thereby permit the central portion a^2 to depend slightly below the surface. This cover *a* is provided with a ring or hook *c*, and after it has been placed in position it usually adheres to the ingot, which is then lifted thereby with the mould *b* when the latter is removed from the ingot by means of removable plugs *d* projecting from the lower end of the mould. Usually the covers *a* adhere to the ingot in a very uncertain manner owing to the gases which are trapped beneath the cover, and this disadvantage is remedied by providing on the underside of the cover, preferably at or about the centre, a projection *e* which when the cover is placed in position first makes contact with the molten metal



Improved Ingot Mould, by Lewis.

and thereby causes it to flow gradually outwards driving the gases out instead of permitting them to be trapped should the contact between the cover and the metal happen to be made first at the edges as occurs in practice. The provision of such a cover renders it possible in some cases to dispense with the plugs *d* or any other additional means for removing the ingot from the mould, as if the latter properly adheres to the cover the ingot can be lifted up by the cover and the mould can be allowed to fall or be knocked off as necessary.

Trade Talk.

THE engineering business of Henry Taylor, Limited, of the Acorn Works, Sheffield, is being offered for sale.

THE MAIDENHEAD IRONWORKS COMPANY, LIMITED, of Maidenhead, are offering their business for sale by private treaty.

THE London offices of the Weardale Lead Company, Limited, have been transferred from 3, Lombard Court, E.C., to Imperial House, Kingsway, W.C.

THE WESTERN ENGINEERING COMPANY, LIMITED, of Bristol, is being wound up voluntarily, with Mr. A. Collins, of Baldwin Street, Bristol, as liquidator.

A FIRE broke out on November 23 at the works of Messrs. Tonks, lock manufacturers and brassfounders, Willenhall, near Wolverhampton, doing considerable damage.

IN future the business of Jonas & Colver, Limited, will be carried on under the style of Sir Joseph Jonas, Colver & Company, Limited, Continental Steelworks, Sheffield.

FURNESS, WITHY & COMPANY, LIMITED, have decided to remove their head offices from West Hartlepool to Liverpool. The change will not be made until the early part of next year.

THE MARINE AND ENGINEERING CONTRACT COMPANY, LIMITED, is being wound up voluntarily, with Mr. W. G. Davis, Friars House, 39-41, New Broad Street, London, E.C., as liquidator.

BURGON & BALL, LIMITED, of the La Plata Works, Malin Bridge, Sheffield, have appointed Mr. Edward Pennington, of 2, Fen Court, Fenchurch Street, E.C., as their London representative.

THE shareholders of the Bainbridge Engineering Company, Limited, have decided that the company be wound up voluntarily, and that Mr. J. R. Woods, 36, Lime Street, E.C., be appointed liquidator.

THE BRYAN DONKIN COMPANY, LIMITED, engineers, ironfounders, etc., of Chesterfield, have removed their London offices from Parliament Mansions to Millbank House, Wood Street, Westminster, S.W.

ALEX. SHANKS & SON, LIMITED, propose erecting a new fitting and erecting shop at their Dens Ironworks, Arbroath, the plans for which have already been sanctioned by the Arbroath Dean of Guild Court.

W. J. JENKINS & COMPANY LIMITED, gas and constructional engineers, iron and brass founders, etc., of the Beehive Works, Retford, Notts., have opened offices in London, at 15, Victoria Street, Westminster, London, S.W.

THE NORTH BRITISH LOCOMOTIVE COMPANY, LIMITED of Glasgow, are reported to have received an order from the Taff Vale Railway Company, for six locomotives to replace those ordered previously from Germany.

AT a meeting of the members of the West of Scotland Iron and Steel Institute, held in Glasgow on November 20, a discussion took place on Dr. C. H. Desch's paper on "The Uniform Nomenclature of Iron and Steel."

THE third meeting of the present session of the Hüddersfield Engineering Society has been held in the Technical College, when Mr. G. T. Rhodes gave a lecture on "The Triumphs of Engineering." Mr. E. Brooks presided.

THE partnership heretofore subsisting between Messrs. F. Fudge and T. Lucas, carrying on business as engineers, at 122, New Kent Road, London, S.E., under the style of F. Fudge & Company, has been dissolved.

MR. P. W. D'ALTON, hitherto chief mechanical engineer to Dick, Kerr & Company, Limited, has established himself in business at Cross Keys House, 56-58, Moorgate Street, London, E.C., as a consulting and inspecting engineer.

MR. E. TRUELOVE has resigned his position with Mr. T. H. Craddock, Market Place, Rugby, and has commenced business on his own account as an agricultural engineer with works in Pinder's Lane, and offices at 92, Kimberley Road, Rugby.

BOLCKOW, VAUGHAN & COMPANY, LIMITED, are celebrating their Jubilee this month, the present company being registered in November, 1864. The original works, however, were established by Messrs. Bolckow & Vaughan as far back as 1841.

A FIRE broke out at 57, Lant Street, Borough, London, S.E., on premises belonging to Bi-Metals, Limited, and Messrs. Neville Williams & Company, electrical engineers, but the damage was not sufficiently heavy to seriously interrupt the business of either concern.

MR. H. STANIFORTH has been appointed London and Southern district agent for James Milne & Son, Limited, with headquarters at 59, Farringdon Road, E.C. Mr. Staniforth was previously with William Sugg & Company, Limited, of Westminster, London, S.W.

THE average price of Scotch pig-iron warrants during the month of October was 55s. 7½d., which compares with 57s. 1½d. in September, 58s. 3½d. in August, 57s. 3½d. in July, 57s. 2¾d. in June, 56s. 7d. in January, and 58s. 5½d. in October of last year. The average price in January, 1913, was 72s. 3½d.

ON Friday, November 13, Mr. G. B. Brook delivered an interesting lecture to the members of the Sheffield Society of Applied Metallurgy, at the Mappin Hall, Applied Science Department of the University of Sheffield, on "Air and Metals: Oxygen, the Enemy of the Melter and Caster and the Metal Worker."

MESSRS. ASHWORTH & PARKER, GREENWOOD & BATLEY, LIMITED and SANDYCROFT, LIMITED, have recently been elected "Members" of the British Electrical and Allied Manufacturers' Association, King's House, Kingsway, London, W.C. The Harland Engineering Company have been elected as "Associates."

THE partnership heretofore subsisting between Messrs. F. M. Knowles & I. Bagnall, carrying on businesses as general engineers, at London Works, Bridge Street, Sheffield, under the style of Knowles, Bagnall & Company, has been dissolved. The business will be continued by Mr. F. M. Knowles in his own name.

MESSRS. ROBERT JENKINS & COMPANY, coppersmiths and makers of welded boilers and tanks, of Wortley Road, Rotherham, Yorks., have appointed Mr. A. S. Smith 62, Burnaby Gardens, Chiswick, London, W., as their temporary agent in London and district. Capt. Jenkins, the Company's representative in London, has been called up.

IN consequence of heavy Government orders considerable extensions have had to be carried out at the Sheffield Works of Vickers, Limited. A new gunshop has been erected during the last month, and further extensions to present workshops are on hand which have necessitated the demolition of a number of houses and the closing of a street.

MR. AUSTIN HOPKINSON, engineer, has made considerable additions to the Delta Works, Guide Bridge, Manchester. The new buildings comprise commercial and works offices, and machine, erecting and smiths' shops. When the equipment of these shops is completed, the present output capacity of the works will be practically doubled.

THE average price of Cleveland pig-iron warrants during October, according to the ascertainment of Messrs. Wm. Jacks & Company, was 49s. 6½d., compared with 51s. 1½d. in September, 52s. 4¾d. in August, 51s. 3½d. in July, 51s. 2¾d. in June, 51s. 4d. in May, 51s. 0½d. in April, 50s. 7d. in March, 51s. 1d. in February, 50s. 6½d. in January, and 52s. 4d. in October last year. The average price in January, 1913, was 66s. 3½d.

MR. JOHN LITTLE, president of the Sheffield section of the Junior Institution of Engineers, delivered an inaugural address to the members of the branch at the opening meeting of the session on October 30. Mr. T. H. Firth presided. Subsequently Messrs. E. B. Christmas, J. R. Hyde, and A. Piggott were elected members of the council: and Messrs. A. J. Hobson, R. D. Nichol, and F. W. Smith members of the subcommittee.

CONSIDERABLE progress has been made with the construction of the new works of Sir W. G. Armstrong,

Whitworth & Company, Limited, at Longueul, Canada. It is understood that the construction of warships will not be undertaken, but that the works will be confined to the manufacture of forgings, shipbuilding sections, castings, shaftings, etc. A tax exemption for 20 years has been granted to the company, and it is anticipated that when in full operation the establishment will find employment for upwards of 4,000 hands.

THE members of the Lancashire Branch of the British Foundrymen's Association on Saturday, November 14, visited the works of Messrs. Jackman & Company, Limited, Blackfriars Road, Manchester. Some fifty members availed themselves of the invitation, and spent a thoroughly interesting afternoon. The working of the various moulding machines and labour-saving appliances was explained by Mr. A. Leidig, managing director, who is a member of the Association. At the conclusion of the visit, a hearty vote of thanks was accorded to Messrs. Jackman, Mr. Sugden, Mr. Leidig, and the staff.

WILLIAM MUIR the sole surviving partner of the firm of Archibald Welsh and Company, brassfounders, Carrick Brass Works, Ayr, was examined in Glasgow Bankruptcy Court, before Sheriff Fyfe, last month. He stated that he began business in 1911, putting £285 into it. He was aware that the firm had been in financial difficulties practically since it started. Asked to explain the deficiency of £2,271, bankrupt said that in his opinion there never was sufficient capital in the business. The statement showed liabilities amounting to £3,075, and assets valued at £803, leaving a deficiency of £2,272 1s. 3d. The examination was closed.

As indicated elsewhere in this issue, the present scarcity of ferro-alloys and metals for steelmaking is likely to be relieved in the near future. It has been known for some time that such a movement was taking shape in Sheffield, and the official announcement is now made of the registration of the High-Speed Steel Alloys, Limited, with a capital of £50,000 in £1 shares. The concern is being supported by the largest of the Sheffield steel works, with one exception, and Sir W. G. Armstrong, Whitworth & Company, Limited, are also represented on the directorate. It is anticipated that by the early spring a regular supply of tungsten and similar metals will be available. In this connection it is interesting to note that T. H. Watson & Company, Limited, of Sheffield, who are the selling agents for the Thermo-Electric Ore Reduction Corporation, Limited, of Luton, state that the latter's works for the manufacture of tungsten metal powder are rapidly approaching completion. Orders have been placed for the whole of the plant required, and Mr. H. Brearley, of Sheffield, who is acting as technical adviser, thinks that the company will be able to commence deliveries early in the New Year.

A NEW liquid-fuel storage and distributing depôt for the Anglo-Mexican Petroleum Products Company, Limited, was completed recently, when the company inaugurated a new and extensive installation at Salt End on the Humber. Salt End is a point from which the continuously growing demand for liquid fuel and the refined products of petroleum can be expeditiously met in the large industrial centres of Yorkshire and the Midlands. The North-Eastern and Hull and Barnsley Railways directly connect the new installation with the companies' main lines, and rail tank cars can draw almost alongside the huge bulk storage tanks to receive their consignments. The installation itself faces the Humber estuary on the northern side, a jetty provided with several pipe-lines leading to the storage tanks, running out to deep water, which at all stages of the tide is sufficient to take the largest tank steamers of the world. The depôt, which covers a site of about twelve acres, has been constructed by Messrs. S. Pearson & Son, Limited. The tankage at present comprises four 95-ft. storage tanks, each capable of holding 45,800 barrels, and two 75-ft. tanks holding 26,800 barrels each, making a total of 236,800 barrels, or 33,800 tons, for fuel oil and other heavy products. There are six 75-ft. tanks for kerosene and motor spirit, capable of holding 26,800 barrels each, while storage accommodation for liquid bitumen for road dressing is also being provided on a large scale.

Alien Enemies.

Patents, Designs and Trade Marks (Temporary Rules) Acts, 1914.

For the information of the public it is thought desirable that the general principles upon which the Board of Trade will act in dealing with applications for the avoidance or suspension of Patents and Trade Marks under the above Acts, should be made known. The principles given below may be taken as generally applicable, but special cases must necessarily receive exceptional treatment.

Patents.

Licences will, as a general rule, be granted, where the applicants fulfil the necessary conditions, set out in Rule 1 of the Temporary Rules :—

(1) Where there is no manufacture in this country under the Patent, and also—

(2) Where what manufacture there is, is carried on by a Company or firm on behalf of *alien enemies* resident abroad, and there is any reason to doubt that the manufacture will continue to be carried on, or where it is in the interests of the country that some other manufacture should be started in the British interests.

Trade Marks.

Suspension will, as a general rule, only be granted in the following cases :—

(1) Where the Trade Mark is the name of a patented article, and a licence is granted under the Patent protecting it.

(2) Where it is the only name or only practicable name of an article manufactured under an expired Patent.

(3) Where it is the name or the only practicable name of an article manufactured in accordance with a known process or a formula which has been published or is well known in the trade.

Generally speaking, suspension will *not* be granted in the case of *pictorial* devices.

ALUMINIUM.—Mr. H. N. Munro, lecturing recently before the Junior Institution of Engineers on "Aluminium," said the commercial possibilities of aluminium were founded in 1887, when Hall in America, and Héroult in France produced the metal by electrical means. Previous to that date, however, investigation had proved that the metal could be easily produced, but methods were too costly for ordinary commercial production. As illustrating the rapid development of the production of aluminium, the price per ton in 1889 was £3,256, in 1891 it was £812, and it has materially decreased until now the price is in the neighbourhood of £80 per ton.

UNCOMPRESSED OXYGEN.—The difficulty in using oxygen in the compressed state is that it must be kept charged in heavy cylinders. Instead of using strong mechanical containers, chemical constraint can be substituted. Thus oxone is a substance in which oxygen is held in chemical bonds, but is releasable by the application of water. Just as water reacts with calcium carbide and forms acetylene gas and lime, so water reacts with oxone and forms oxygen and sodium hydrate. A pound of this reagent holds 2.2 cub. ft. of gas or 60 litres of oxygen at normal pressure and temperature. Thus a pound of oxone should furnish a man enough oxygen for 30 minutes of use. The oxygen evolved is said to be 99 to 100 per cent. pure, the only impurity consisting of a slight vapour caused by the energy of reaction. This is readily absorbed by passing the gas through water. The gas is then of 100 per cent. purity. Oxone is a commercial preparation of fused sodium peroxide of specific gravity 2.43. It is hard, but not brittle, and is capable of being cast into any convenient shape, and it is said it can be stored without danger and even without deterioration if protected from moisture.

Deaths.

THE death has taken place Mr. J. G. Smith, late secretary to Merry & Cunninghame, Limited.

THE death is reported of Mr. F. Wootton, of Wootton Bros., Limited, engineers and ironfounders, of Coalville, near Leicester, at the age of 29 years.

MR. J. SUMMERSCALES, a director of W. and S. Summerscales & Sons, Limited, ironfounders, of the Parkside Works, Pitt Street, Keighley, died recently at the age of 77 years.

MR. FRANK PEARN, the chairman and founder of Frank Pearn and Company, Limited, engineers, West Gorton, Manchester, died, after a long illness, on Wednesday, November 11.

THE death has occurred in London at the age of 69 years of Mr. E. B. Ellington, a past-president of the Institution of Mechanical Engineers, and founder of the General Hydraulic Power Company.

THE death has taken place at the age of 75 years, at the South Bungalow, Hornsea, of Mr. R. Sizer, a director of Richard Sizer, Limited, engineers and machinery merchants of the Cornwall Works, Hull.

MR. T. PATERSON, who was on the engineering staff of Harland & Wolff, Limited, engineers and shipbuilders, has died as the result of an accident at the company's branch works at Southampton.

THE death has occurred of Mr. W. B. Bryan, a member of the council of the Institution of Mechanical Engineers, who for the past ten years had filled the position of chief engineer to the Metropolitan Water Board.

MR. E. J. BROWN, at one time secretary of Sanderson Bros. & Newbould, Limited, of Sheffield, died at Llandudno, North Wales, on November 22, at the age of 64 years. The deceased gentleman left the company's service some years ago.

THE death is reported of Mr. T. Baxendale, of Woodleigh, Chorley, Lancs., at the age of 65 years. The deceased gentleman was a partner in the business of Messrs. Richard Baxendale & Sons, iron founders, of the Albert Works, Chorley.

THE death took place on October 30, at his residence in Kilmarnock, of Mr. Alexander Auld, who for about fifty years was in the employment of Andrew Barclay, Sons and Company, Limited, Caledonia Works, Kilmarnock, and for many years acted as their outside representative.

MR. ISAAC ROBINSON, one of the oldest residents of East Cleveland, and one of the originators of the Loftus iron and brass foundry trade, died on November 25. He was 72 years of age, and had been a member of the Guisborough Board of Guardians for about 40 years.

THE death is announced of Mr. H. E. Lupton, head of Messrs. H. E. Lupton & Sons, iron and brass founders and finishers, of the Scaitcliffe Foundry, Ranger Street, Accrington, and the Portland Works, Croft Street, Bradford. The deceased gentleman was 65 years of age.

MR. J. GIMSON a director of Gimson & Company, (Leicester), Limited, engineers and ironfounders, Vulcan Street, Leicester, died recently at the age of 71 years. The deceased gentleman had been associated with the business for over half a century, and was the senior director of the company.

THE death took place recently, at the age of 63 years, of Mr. Wm. Woodhead, the founder of the business of Wm Woodhead and Company, Limited, engineers, Boothtown Mills, Halifax. The deceased gentleman started his business career with John Stirk and Sons, Limited, engineers and ironfounders, of Ovenden Road, Halifax, subsequently establishing the toolmaking business of Messrs. Woodhead.

THE death occurred on October 13 of Mr. Alfred Sang, who was at one time vice-president of the Garland Corporation of U.S.A., and at the time of his death was their confidential agent in London. The deceased gentleman had been serving with the Allied forces at the front, and his death resulted from wounds received at the siege of Antwerp. He was born in Paris, in 1874, of English parentage, and graduated at a leading French technical school. In 1900 he went to Pittsburg, U.S.A., becoming a member of the Garland Corporation. He was a very progressive analytical chemist, and made some important discoveries and improvements in the Sherardizing process. In June, 1909, he returned to Paris, taking over the Sherardizing patents for France, and subsequently came to London, where he formed the firm of Sang & Russell, metallurgical engineers.

WE regret to announce that the death of Mr. Joseph Pointer, M.P. for the Attercliffe Division of Sheffield, occurred on November 19, at his home in Stafford Road, Park, Sheffield. Mr. Pointer had been ill for the past four months, and died at the early age of 39. The son of a working-man, Mr. Pointer attended Attercliffe Board School, also the Central Secondary School. Later, when about 24 years of age, he went to Ruskin College, Oxford, where he stayed about six months, studying constitutional history and sociology. He was apprenticed to the trade of a pattern-maker, and held various unpaid offices in the United Patternmakers' Association. By politics a socialist, Mr. Pointer was actively associated with the Sheffield Independent Labour Party (of which he became president), and the Sheffield Trades and Labour Council. He was early marked out by his Party as a candidate for public office. After two unsuccessful attempts, he secured election to the Sheffield City Council. He was elected to Parliament in the Labour interests in 1908, and became ultimately Junior Whip of that Party. Mr. Pointer was personally very popular, and his death will be widely regretted.

Personal.

MR. J. E SWEET, president of the Straight Line Engine Company, of Syracuse, N.Y., U.S.A., is to be awarded the John Fritz medal this year.

MR. G. E. BAIRSTO, of University College, has had the degree of D.Sc. (Engineering) conferred upon him by the Senate of London University.

THE late Mr. G. H. Dewsbury, managing director of Wm. Turner & Son, Limited, steel manufacturers, of the Caledonia Works, Sheffield, left estate valued at £17,415, including net personalty £16,750.

THE Council of the University of Sheffield have appointed Mr. H. J. Davies to the post of Demonstrator in Engineering, and Mr. F. Orme to the post of Demonstrator in Non-ferrous Metallurgy.

MR. T. F. WARD, managing director of Sir B. Samuelson and Company, Limited, Newport Ironworks, Middlesbrough, has been the recipient of a presentation from the officials and men in recognition of his 50 years' connection with the firm.

MR. W. F. CLEMENT, who for the last six months has held the position of departmental manager to the Blaenavon Company, Limited, Blaenavon, Mon., has now been appointed works manager.

MR. J. E. ROBINSON has been elected chairman of the South Durham Steel and Iron Company, Limited, in place of the late Sir Stephen Furness, Bart., M.P. The Right Hon. Lord Furness has been elected to the directorate to fill the vacancy, while Mr. G. S. Barwick has also been elected on the board.

THE many friends of Mr. Martin Hawke, managing director of the Carborundum Company, Limited, of Trafford Park, Manchester, will be interested to know that his son, Mr. Clarence Hawke, was the author of the interesting paper on "Abrasives" read before the Chicago Convention of the American Foundrymen's Association and reproduced in the November issue of THE FOUNDRY TRADE JOURNAL.

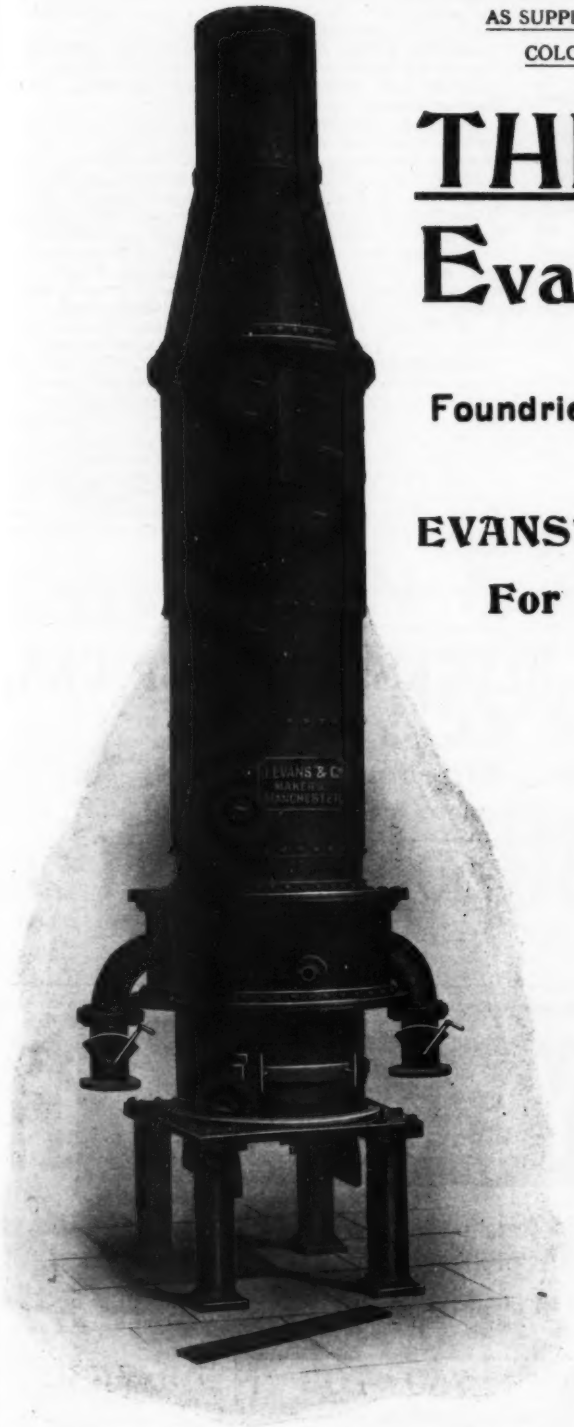
MR. J. M. WEIR, who has recently been elected President of the Newcastle Branch of the British Foundrymen's Association, is the manager of Mr. C. W. Taylor's extensive foundries, viz., The Temple Town Foundry and Engineering Works, and the North-Eastern Foundry, South Shields, a position which he has held for the past 12 years. Under his supervision were made many of the large turbine castings for H.M. latest battleships, cruisers and destroyers.

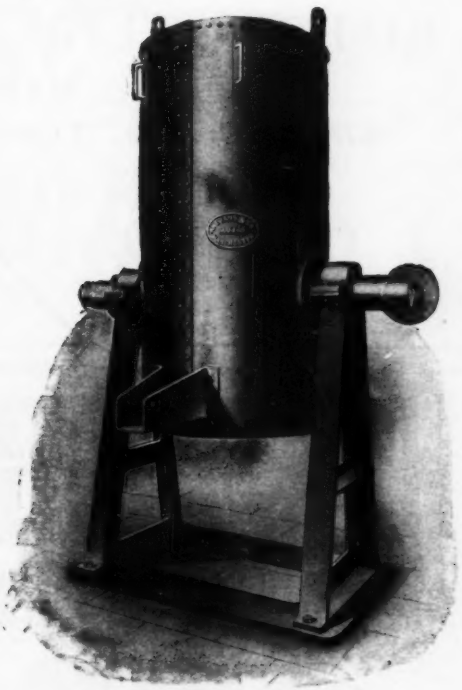
AS SUPPLIED TO THE ADMIRALTY, WAR OFFICE, COLONIES, AND FOREIGN GOVERNMENTS.

THE Cupola. Evans's Rapid.

Foundries Completely Furnished.

EVANS'S NEW CUPOLETTE
For Emergency Work.





James Evans & Co.,
Britannia Works,
Blackfriars,
MANCHESTER.

Telegrams: "LADLES, MANCHESTER."
Telephone: 2297 CENTRAL, MANCHESTER.

New Companies.

Anglo Russian Export and Import Corporation, Limited.—Capital £1,000 in £1 shares. Registered office: Palmerston House, Bishopsgate, London, E.C.

Summit Manufacturing Company, Limited.—Capital £500 in £1 shares, to carry on the business of tool manufacturers. Registered office: 41, Borough Road, London, S.E.

Bolton Lead Works, Limited.—Capital £4,000 in £1 shares, to acquire the business formerly carried on by the late J. F. Power, at Bolton, as J. F. Power and Company.

English Iron and Steel Company, Limited.—Capital £1,000 in 1,000 participating preference shares of 5s. and 750 ordinary of £1. Registered office: 58a, City Road, London, E.C.

W. A. Clabour, Westbay & Company, Limited.—Capital £2,000 in £1 shares, to carry on the business of ironfounders, etc. Registered office:—Wyther Lane, Kirkstall, Leeds.

Smart & Clark, Limited.—Capital £2,000 in £1 shares, to carry on the business of engineers. Registered offices: Clifden Works, 6a, Clifden Road, Clapton, London, N.E.

Implitico, Limited.—Capital £3,000 in £1 shares, to carry on the business of electricians, mechanical engineers, etc. Registered office: 2-6, Pocock Street, Blackfriars, London, S.E.

London Filter and Pump Company, Limited.—Capital £3,000 in £1 shares. S. A. Dean is the first director and secretary. Registered office: 14-16, Hanway Street, London, S.W.

Carstone, Limited.—Capital £3,000 in 2,500 preference shares of £1, and 5,000 ordinary of 2s., to carry on the business of engineers. Registered office: Vernon House, Silician Avenue, Bloomsbury Square, W.C.

Douglas Turner & Company, Limited.—Capital £2,000 in £1 shares (1,000 6 per cent. preference), to acquire the business of a steel and file merchant carried on by D. Turner at Wentworth Works, 33, Andrew Street, Sheffield, as Douglas Turner & Company. The first directors are D. Turner and Mrs. C. W. Turner (both permanent). Registered office: Wentworth Works, 33, Andrew Street, Sheffield.

High Speed Steel Alloys, Limited.—Capital £50,000 in £1 shares, to carry on the business of manufacturers of and dealers in tungsten, molybdenum, vanadium, chrome and any other metals or substances used in connection with the manufacture of steel. The first directors are A. Balfour, A. J. Hobson, F. Best, Norfolk Works Sheffield; H. H. Smith-Carington, Openshaw, near Manchester; W. Clark, River Don Works, Sheffield; and O. W. Fawcett, Clyde Steel Works, Sheffield. Registered office: 13, East Parade, Sheffield.

GANISTER, CUPOLA BLOCKS, FIRE BRICKS,
FIRE CLAY.
Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.
STEEL MOULDERS' COMPOSITION, SILICA CEMENT.
J. GRAYSON LOWOOD & Co., Ltd.,
DEEPCAR, nr. SHEFFIELD.
Telegrams: "LOWOOD, DEEPCAR"

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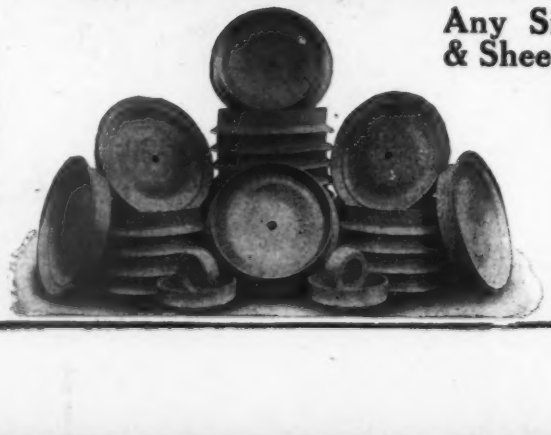

Any Size or Weight. From Plate & Sheet-Metal. Rough or Machined.
Rolled or Spun Sheet Steel Work, Light Pressed Steel Wheels. General Sheet Metal Work. Foundry Ladles.
Our Equipment includes
750 TON HYDRAULIC
and other
Presses and Stamps.
Send us details of your requirements and we will quote you.
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TRADE SIROCCO MARK

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Made in eight sizes from 10-in. to 35-in. diameter, and suitable for melting ½ to 20 tons per hour at pressures from 12—30 inches Watergauge.

Cast Iron Casings and Ball Bearings.

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DAVIDSON & CO., LIMITED,

Sirocco Engineering Works,

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ELDERS FOUNDRY COKE

AS SUPPLIED TO THE BRITISH ADMIRALTY DOCKYARDS.

The following, selected from numerous letters, are eminent testimony as to the quality of our celebrated "A.A.A." Coppee Foundry Coke, carefully selected, and despatched in sheeted wagons.

From PECKETT & SONS, Bristol.

Bristol, October 25th, 1904.

We have been using your Selected Foundry Coke for some considerable time.
We have pleasure in stating that we are very pleased with it, as we find we get sounder and cleaner castings, more free from blowholes and other defects, than we formerly did.

From BOW, McLACHLAN & CO., LTD. (Paisley Foundry), Paisley, Glasgow.

Paisley, 12th March, 1909.

We have yours of 4th inst., and in reply have pleasure in stating that we have been using you Foundry Coke for several years for special purposes with highly satisfactory results.

Elders Collieries, Ltd., Cardiff.

Telegraph: ELDER, CARDIFF. Telephone: 4640 and 4641.

MONTHLY PRICE LIST.

The undermentioned prices, unless otherwise specified, are those obtaining on the first day of the current month.

Pig-Iron.

Cleveland.

	s.	d.
Cleveland No. 1	54	3
,, No. 3	52	0
,, No. 4 foundry	51	6
,, No. 4 forge	51	0
,, Mottled	50	6
,, White	50	6
East Coast hematite, mixed Nos.	65	0
Cleveland warrants	51	11

Above prices are for early f.o.b. deliveries, and as regards Cleveland iron are for G.M.B. brands. The warrant quotations are the sellers cash prices.

Scotland.

	s.	d.
Standard Foundry (Glasgow Market settlement price)	51	6
Warrants, ditto	57	10½

Makers' prices:—	s.	d.		s.	d.
Gartsherrie No. 1	69	6	No. 3	64	6
Coltness No. 1	68	0	No 3	68	0
Summerlee No. 1	69	0	No. 3	64	0
Langloan No. 1	69	0	No. 3	64	0
Calder No. 1	69	0	No. 3	64	0
Clyde No. 1	69	0	No. 3	64	0
Carnbroe No. 1	67	0	No. 3	63	0
Monkland No. 1	64	0	No. 3	63	0
Shotts No. 1	68	6	No. 3	63	6

(All deliverable alongside Glasgow.)

Glengarnock	No. 1	70	0	No. 3	65 0
Eglinton	No. 1	64	0	No. 3	63 0

(All deliverable alongside Ardrossan.)

Dalmellington	No. 1	66	0	No. 3	64 0

(Deliverable alongside Ayr.)

Carron	No. 1	70	6	No. 3	65 6

(F.a.s. Grangemouth.)

Lancashire.

	s.	d.	s.	d.
Lancashire No 3 foundry f.o.t.	—		—	
Lincolnshire No. 3 foundry	—		58	3
Derbyshire No. 3 foundry	—		58	0
Staffordshire No. 3 foundry	—		59	0
Cleveland No. 3 foundry	—		59	0

(All delivered equal Manchester.)

Scotch No. 3	Gartsherrie	—	69	0
	Glengarnock	—	67	6
	Eglinton	—	67	6
	Summerlee	—	68	0

(Delivered Manchester Docks.)

North-West of England.

	s.	d.	s.	d.
Bessemer mixed numbers net f.o.b.	—		67	6
Hematite warrant net cash	—		64	0
Lorn cold-blast charcoal iron	180	0	190	0

The Midlands.

		s.	d.	s.	d.
Staffs.	Common forge	51	0	54	0
	Part Mine forge	54	0	55	0
	Best All Mine	80	0	82	6
	Cold Blast	—		130	0

Strong forge, about 1s. less than grey forge; Mottled and White, about 2s. less than forge; Foundry No. 3, 3s. to 5s. above forge; No. 1 and No. 2, from 1s. 6d. to 2s. above No. 3; No. 1, about 2s. above No. 2.

Northampton foundry	—	—
North Staffs. foundry	—	—
Derby foundry	—	—
Nottinghamshire foundry	—	—
Leicestershire foundry	—	62 0
Shropshire Cold-Blast	—	132 6

(Delivered South Staffordshire Works, net cash monthly.)

Lincolnshire.

	s.	d.	s.	d.
Forge	—		—	
Grey forge	—		—	
Basic	—		—	
No. 3 foundry	—		54	0
No. 4 foundry	—		—	

F.o.t. Makers' works.

South Wales.

	s.	d.	s.	d.
Welsh Hematite	71	6	72	6

Ferro-Alloys.

Net, Delivered Sheffield Steel works.

	£	s.	d.	£	s.	d.
Ferro-chrome: 4/6% carbon. Basis 60%, scale 10s. per unit. Per ton	26	0	0			
Ferro-chrome: 6/8% carbon. Basis 60%, scale 10s. per unit. Per ton	24	0	0			
Ferro-chrome: 8/10% carbon. Basis 60%, scale 8s. 6d. per unit. Per ton	22	15	0			
Ferro-chrome: Specially refined, guaranteed maximum 2% carbon, broken to small pieces for use in best quality crucible steels. Basis 60%, scale 22s. per unit. Per ton	58	0	0			
Ferro-vanadium: 33/40% Va., per lb. of Va. contained in the alloy	0	9	6			
Ferro-silicon: 45/50%. Basis 50%, 5s. scale per unit Per ton	15	5	0			
Ferro-titanium: 15/18%, per pound, flat	0	0	6½			
Ferro-molybdenum: 70/80% Mo. per pound of Mo. contained	0	18	0			
Ferro-phosphorus: 20/25%. Per ton	16	10	0			
*Ferro-manganese 80%	10	5	0	10	10	0
,, export	—					

* F.o.b. Liverpool.

Iron Castings.

Cleveland.

	£	s.	d.	£	s.	d.
Columns (plain)	7	7	6	to 7	12	6
Pipes, 1¼ to 2½ in.	6	7	6	6	12	6
,, 3 to 4 in.	5	17	6	6	0	0
,, 5 to 8 in.	5	12	6	5	15	0
,, 10 to 16 in.	5	15	0	—		
,, 18 to 24 in.	5	15	0	—		
Chairs	4	5	0	4	6	0
Floor plates (open sand)	3	10	0	3	12	6

(At works.)

Non-Ferrous Metals.

Copper.

	£	s.	d.	£	s.	d.
Standard, Cash	56	10	0	56	15	0
Three months	56	10	0	56	15	0
Electrolytic	—			59	10	0
Tough	—			59	0	0
Best selected	—			59	5	0

Tin.

Standard, Cash	—	146	15	0
,, Three months	—	145	5	0
English Ingots	—	153	10	0
Bars	—	154	10	0
Refined	—			

Spelter.

Silesian	—		
Specials	—		
Hard	—	21	0 0
British	—	27	0 0

Lead.

Soft foreign	—	19	2	6
English	—	19	10	0

Antimony.

Regulus	—	50	0	0

Aluminium.

Virgin Metal, 98/99% per ton		84	0	0

*Chromium (Metallic).

98/99% purity per lb.	—	

*Nickel.

In cubes, 98/99% purity Per ton	202	10	0	

*Tungsten Metal Powder.

96/98% purity per lb.	0	5	0	

*Molybdenum Metal.

96/98% purity per lb.	—	

*Cobalt Metal.

97% purity per lb.	0	8	0	

Quicksilver.

75 lb. bottle	11	2	6	

* Net, Delivered Sheffield Works.

Scrap Iron and Steel.

Cleveland.

	s.	d.		s.	d.
Steel scrap, heavy melting	50	0	to	51	0
Iron scrap cast (cupola metal)	52	6		55	6

London (f.o.b.).

Heavy steel	50	0
Light ,,	32	6
Heavy cast	49	0

Non-Ferrous Scrap.

London merchants quote, delivery free, and subject to market fluctuations:—

	J. B. Garnham and Sons.			A. Joseph.		
	£	s.	d.	£	s.	d.
Brass	39	10	0	42	0	0
Clean copper	53	0	0	54	0	0
Brasiery copper	48	0	0	49	0	0
Old lead	17	10	0	18	0	0
Tea lead	—			17	0	0
Old zinc	17	0	0	20	0	0
Hollow pewter	—			105	0	0
Black pewter (shaped)	—			70	0	0
Gun metal	49	10	0	54	0	0
Aluminium (cuttings)	—			64	0	0

Stocks.

Pig-Iron in Public Store.

	Dec. 3.	Inc. + or Dec. — since Dec. 4, 1913.
	Tons.	Tons.
Connal's at Glasgow Scotch	1,000	No change.
Ditto other makes	—	— 20
Connal's at Middlesbrough	105,291	— 42,457
Connal's at Middlesbrough hematite	—	No change.
West Coast hematite	4,011	— 5,057

Metals.

Copper, Europe and afloat	35,749	+ 8,992
Tin, London, Holland, U.S.A. and afloat	13,627	— 2,485

Coke.

Middlesbrough.

	s.	d.		s.	d.
Gas Coke	12	0		—	
Foundry Coke	18	6	to	19	0
Furnace coke	—			17	6

Newcastle-on-Tyne.

F.o.b. Dunston.

FOUNDRY COKE—	s.	d.
Original Garesfield	20	3
Mickley	19	3
Stella Garesfield	20	0
Priestman's Garesfield	20	0
Consett Garesfield	20	0
Newcastle gas coke	11	3

Cardiff.

	s.	d.		s.	d.
Special foundry coke	27	0	to	30	0
Foundry coke	20	0	to	24	0
Furnace coke	17	0	to	19	0

Leeds.

Furnace coke (washed)	10	3	to	10	6

Birmingham.

Foundry coke	—			—
Furnace ,,	15	0	to	17	0
Gas ,,	—			—

Glasgow.

Foundry coke	—	—
Furnace ,,	—	—
Gas ,,	—	—

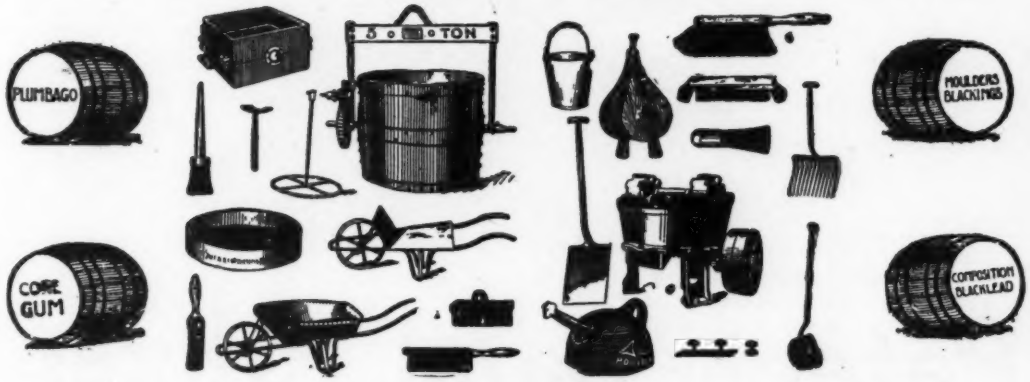
London.

Foundry coke	25	0	to	30 0
Gas coke (Beckton), into barge	—			11 9
,, into wagon at Works	—			12 9
Gas coke, Provincial (London sidings)	14	9	to	15 0

Established 1863.

JAS. DURRANS & SONS,

Phœnix Works, Penistone, Near Sheffield.



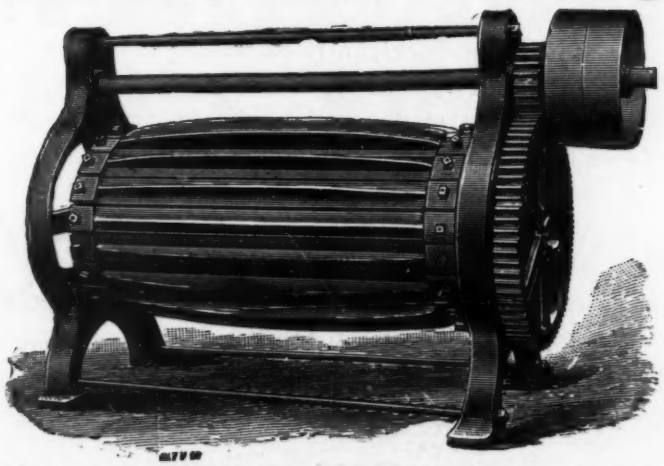
Manufacturers of all

FOUNDRY EQUIPMENTS

COMPOSITION BLACK LEAD, PLUMBAGO, CORE GUM, WHITE DUST & COAL DUST

Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Improved Foundry Rattler or Fettling Drum.

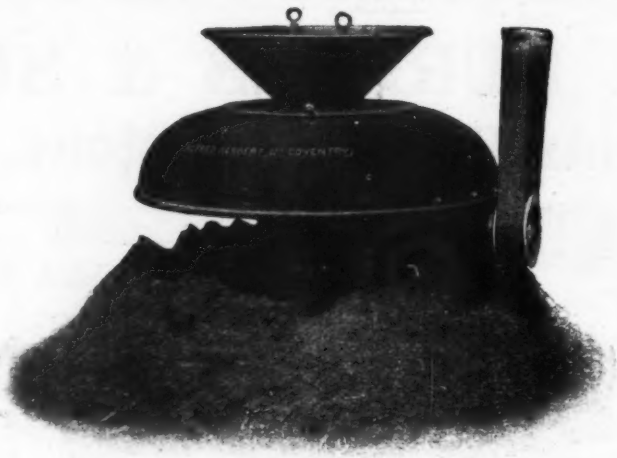


These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.

The following testimonial explains itself :—

"Dear Sirs,—We have been using your best Blacking for a large number of years, and always use it on our large Ingot Moulds, which, as you know, we have made up to 85 tons in weight.

Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD.



Patent Sand Mixer

Uses up more old sand than has hitherto been considered possible.

Our Patent Sand Mixer has the following desirable advantages.

The sand is thoroughly aerated, rendered light and loose in texture and of even temper.

Previous milling of the sand is unnecessary.

Seven hundredweights of sand dealt with per minute.

All bearings are ball bearings.

All gears are casehardened steel.

All gears and bearings run in an oil-bath rendering them practically everlasting.

Cages easily examined and cleaned.

Cages do not clog as there are no curved passages.

Machines can be seen in operation in our foundries, Edgwick, Coventry.

ALFRED HERBERT, Limited,

Coventry.

SITUATIONS VACANT AND WANTED.

BRASS FOUNDRY FOREMAN wants position; 31 years' experience, 14 in U.S.A. Knows Business from A to Z. All up to date methods on all kinds of metals. —Address Box 540, Offices of THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

WANTED, FOUNDRY FOREMAN, thoroughly experienced in high class Engine Castings. Must have special knowledge of Gun-metal Mixtures for heavy pressures and all Admiralty test requirements. About 60 hands employed. None but thoroughly reliable, experienced men with good references need apply. Good permanent position for suitable man.—State age, wages, and full particulars, to Box 547, Offices of THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

FOR SALE AND WANTED.

HALL'S INVINCIBLE SAND MIXERS are now successfully in use for preparing NEW SANDS and UTILIZING OLD SANDS in some of the LARGEST FOUNDRIES.—Write for information and prices to C. E. V. HALL, Paradise Chambers, Sheffield.

TO BRASS FOUNDERS AND OTHERS.—For SALE, almost new HAND MOULDING MACHINE, SAND MILL, ROTARY SIEVE, First Class GAS ENGINE, LATHES, and other Machines.—Apply Box 490, Offices of THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

FOR SALE.—Three MOULDING MACHINES, by Pickles, Bradford, replaced by Pneumatic.—Particulars from T. H. PICKLES & SONS, Empress Foundry, Mytholmroyd.

FOR SALE AND WANTED—(*Continued.*)

TWO RICHMOND GAS CRUCIBLE FURNACES, 60 lbs., 11 in. dia.
One 12 in. sq., by Brayshaw, Manchester.
Two J. Wright GAS BRASS MELTING FURNACES, 11 in. dia.
T. KING, Engineer, Maidstone.

FOR SALE.—STEEL FOUNDRY LADLES, with Worm Gearing, in first-class condition.
1 15 Tons capacity, 5 ft. dia. by 5 ft. deep.
1 7 ,, ,, 4 ft. ,, by 4 ft. ,,
1 5 ,, ,, 3 ft. 5 in. ,, by 3 ft. 3 in. ,,
THOS. W. WARD, LTD., Silvertown, E.

COMBINED MORTAR MILL, ENGINE and BOILER, 7 ft. pan; ditto, with 6 ft. pan.
JOSEPH PUGSLEY, Cattybrook Ironworks, Lawrence Hill, Bristol.

NAISH & CROFT,
Consulting Metallurgists and Analytical Chemists.
— SPECIALISTS IN FOUNDRY WORK. —
Laboratory for all kinds of Metallurgical Investigations.
ANALYSES. MICROGRAPHS. MECHANICAL TESTS.
When you have trouble write us. Fees on application.
Special Terms for Contract Work.
Address : **150, ALMA STREET, BIRMINGHAM.**
London Office : 9 & 10, Fenchurch Street.

FRODAIR
SPECIAL PIG IRON
for
CYLINDERS, CHILLED CASTINGS, MACHINE CASTINGS, and any :: :: FOUNDRY PURPOSE. :: ::

ASK FOR OUR SUGGESTIONS FOR ECONOMICAL IRON MIXTURES.

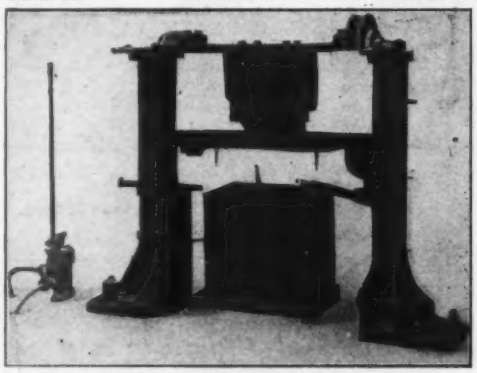
THE FRODAIR IRON & STEEL CO., LTD.,
Fenchurch House, LONDON, E.C.

THE "CHIPCHASE" PATENT

MOULDING MACHINE.

(HYDRAULIC or PNEUMATIC)

SIMPLE - STRONG - DURABLE



This illustration shows the 3rd position in the making of axle boxes.

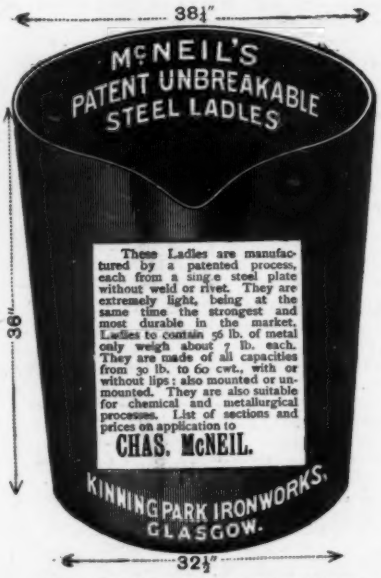
THE "CHIPCHASE" PATENT JARRING MACHINE.

THE "CHIPCHASE" PATENT CORE MAKING MACHINE.

Sole Makers—

DAVID BRIDGE & Co., Ltd.,

CASTLETON FOUNDRY, CASTLETON, MANCHESTER.


38½"
McNEIL'S
PATENT UNBREAKABLE
STEEL LADLES
These Ladles are manufactured by a patented process, each from a single steel plate without weld or rivet. They are extremely light, being at the same time the strongest and most durable in the market. Ladles to contain 56 lb. of metal only weigh about 7 lb. each. They are made of all capacities from 30 lb. to 60 cwt., with or without lips; also mounted or unmounted. They are also suitable for chemical and metallurgical processes. List of sections and prices on application to
CHAS. McNEIL.
KINNING PARK IRONWORKS,
GLASGOW.
36"
32½"

Can also be made in Aluminium.

WHITTAKER'S IMPROVED MOULDING MACHINE

By which Wheels or Pulleys of any description or size from 3 inches to upwards of 20 ft. diameter can be made.

The most complete and efficient machine hitherto introduced to Engineers.

All Machines warranted to Mould with the greatest accuracy and precision.

GEARING WHEELS

Spur or Bevel, Straight Teeth and Double Helical Teeth Supplied to Consumers.

ROPE & BELT PULLEYS.

WM. WHITTAKER & SONS, LTD.,

SUN IRON WORKS, *OLDHAM.*

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